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The Favors of Politics

IT is the irony of politics that the sole tangible, although indirect, result of the legislative investigation of the New York Public Service Commissions to this time is the displacement of the one remaining member appointed to the original First District commission by Governor Hughes. To say that Mr. Maltbie was displaced because the commission was investigated would be neither accurate nor fair; his term expired on Feb. 1, and under the law he continued in office until the appointment of his successor. As his office was at the disposal of Governor Whitman, the investigators did not seek his removal. They were after the four Democratic members, the charges against whom appear at this writing to have lost potency. After nearly eight years of service, Mr. Maltbie had a knowledge of the companies and an experience in the administration of the law that all of his colleagues in the First District commission lack. The newly appointed member unfortunately fails to possess these advantages, but as counsel he conducted the investigation, and by all the rules of politics he was entitled to a place.

Capitalization of Unproductive Improvements

THE capitalization of improvements which are not directly productive of revenue has engaged the attention of the Board of Gas & Electric Light Commissioners of Massachusetts in a case affecting the Edison Electric Illuminating Company of Boston. The most important expenditures relate to welfare buildings. We understand that the board decides that if such expenditures pass beyond suitable provision for health and safety of employees and are so large as to add extra burdens to consumers or diminish stockholders' rights to a fair return, capitalization is of "doubtful propriety." The real question, then, is one of judgment. Since the board may hold that the judgment of the company is wrong, the only safe course for the company is to submit its plans in advance to the board. The board may as well assume responsibility before the expenditure as afterward. To put handicaps upon welfare work is to oppose strong tendencies of the times. Welfare work promotes efficiency, happiness in occupation and permanence in office, and thus improves service. If great railroads were prevented from capitalizing costs of attractive terminals and other similar improvements on the just ground that they are not revenue producers, their burdens on income would be smaller but their patrons would be bitterly disappointed.

Reports to Public Authorities

THE numerous reports required by public bodies are a perennial trial to operating officials. One of the heavy costs of regulation is the cost of preparing the reports to be submitted by the companies to local, state and interstate officials. So serious has the matter become that it offers an inviting field of research for the student of efficiency and conserver of resources. Mr. Newcomb Carlton points out that the Western Union Telegraph Company makes 17,000 statements annually to public authorities. As this company has $46,264,000 gross operating income, it makes one report for every $2,614 of income. Though many of the reports, such as those to taxing bodies, cannot be dispensed with, it is not necessity that fathers so monumental a waste. Plainly there is an absence of co-operation by public authorities as well as a duplication of jurisdiction and an excessively large bolt of red tape. Companies are under obligation to comply with all reasonable regulations, but the cost must be added to their charges for service.

Effect of Pressure on Dielectric Strength

IT is now well known that the dielectric strength of air is markedly increased by increase of its pneumatic pressure. That is, dense air is much stronger, electrically, than rarefied air. A similar relation applies to gases in general. The effect of pressure on the dielectric strength of liquids or solids is, however, much less generally known, and there is still much room for investigation in those directions. An article on this subject by Mr. F. Kock has recently appeared in the *Elektrotechnische Zeitschrift*. It appears that, in all the tests reported, pressure, if it has any noticeable effect on the dielectric strength, always tends to increase it. In other words, no case has yet been found of an insulating substance the dielectric strength of which was lessened by application of hydrostatic pressure. Assuming an insulating substance to break down under stress by reason of some kind of molecular orientation whereby ionization can occur after the orientation has been effected, then it is easy to understand that the application of hydrostatic pressure to the substance may tend to keep the material molecularly locked together, and thereby to increase the voltage gradient that must be applied in order to effect a breakdown. The author shows that when a liquid insulator is submitted to pressure the first effect is to increase the dielectric strength, according to a straight-line law. After a while the dielectric strength increases less

rapidly, and finally, when the pressure has attained a certain value, further increase in the hydrostatic pressure has little effect on the dielectric strength. It also appears that, at least in certain liquid insulators, the dielectric strength is greater at higher than at lower frequencies, when the insulator is compressed, whereas at ordinary atmospheric pressures the dielectric strength is not appreciably affected by the pressure. Similarly, under pressure, the dielectric strength is reported greater for alternating-current than for direct-current stress. It is evident from the results of such experimental investigations that much more material must be collected before we can hope to arrive at a satisfactory theory of dielectric strength in insulators.

A Notable Isolated Plant

There is always some doubt in the mind of the inquirer regarding the economics of isolated plants, and in many instances examination shows that central-station supply offers a cheaper source of energy. It is only in plants large enough to have a large and fairly steady output that independent operation shows good reason for being. To this class belongs the installation of the Curtis Publishing Company, described in this issue. Not only is it of greater actual output than many a highly respectable central station, but it has an added reason for economic existence in the need for steam-heating facilities, which demands a boiler plant quite irrespective of the demand for electrical energy. As might well be surmised from the magnitude of the business conducted in it, the new building of the company is of imposing dimensions, ten stories high, and containing 14,500,000 cu. ft. In it is conducted the whole publishing and printing business of the great group of periodicals which have acquired a world-wide reputation. As a part of the equipment there has been provided one of the large isolated plants of the country —a plant exceptional in size and flexibility and equipped with every modern labor-saving device.

Inasmuch as the demand for steam for heating purposes is large, the use of exhaust steam was highly important, and hence the engines are operated non-condensing. They are of the cross-compound type directly connected to their generators and worked at high initial pressure and with the advantage of considerable superheat. In fact, one may say that no condition of economy was overlooked save the one contra-indicated by the demand for exhaust steam. The boiler equipment is installed on the third floor, with the fuel bins above and the ash room below. Local conditions rendered it desirable to resort to hand-firing, but in every other respect the operation of steam production is as nearly automatic as possible. All of the generators are of the direct-current type and operate at the same voltage, 230, at which pressure the elaborate distribution system of the building, with its 4000 hp in motors, is operated. The lighting load is taken care of by balancer sets, which provide three-wire distribution at 115 volts.

Although the equipment is such as to leave very small possibility of any complete break-down, yet, as an extra precaution, provision has been made for an emergency connection with the lines of the Philadelphia Electric Company. This provision applies only to a system of emergency lamps, but their connection in case of need is automatic. An unusual feature of the distribution system is that the energy consumed by each department of the company is metered so that all the energy charges can be equitably distributed. Throughout the building the lighting and motor-service equipment is most complete, and the entire plant exhibits a certain exceptional thoroughness well in keeping with the enterprise of the organization it serves.

Incandescent Versus Arc Lamps

That the gas-filled lamp would make serious inroads upon the use of the arc lamp for street lighting was a foregone conclusion from the very first appearance of this latest development of incandescent lighting. The vital question relates to the extent to which the substitution of incandescent for arc lamps is justified. Hundreds of central-station managers are worried over the matter and are rather in a quandary as to the steps to be taken when their present contracts are to be renewed. The simplicity of the incandescent lamp, its high efficiency, and its steadiness, are very strong points in its favor, besides which it appeals to the imagination of the man on the street as a new thing worthy of encouragement, and if anything further were needed to worry the advocates of the arc lamp it may be found in the present war, with its practical suppression of traffic in the electrodes quite generally imported for use in flaming-arc lamps.

Broadly, the effect of the gas-filled lamp will be salutary. The first activity should be to put out of business all the old and inefficient types of carbon arc lamp, open and inclosed, especially those of the alternating-current type. There is no excuse whatever for continuing, for example, the use of the 6.6-amp alternating-current lamp, save the one of unwillingness to incur the expense of a change to incandescent lamps. Even the 7.5-amp alternating-current arc lamp is sure to follow its smaller mate into oblivion, with direct-current arc lamps, open and inclosed, not far in the rear. The flaming-arc and luminous-arc lamps present another problem. They are quite as efficient in the matter of light-giving power as are the gas-filled incandescent units, are of conveniently large power, and possess a material advantage in their much more striking effect upon the street, due to the white color given by the electrodes now commonly in use. These lamps give to street illumination a distinctive character which it seems somewhat to lack when the change to incandescent lamps is made. The white arc lamps belong to the street itself, while the yellowish incandescent units seem to melt into the general illumination along the way without possessing any individuality of their own. Only when they are so closely spaced as to command attention do they

seem an important factor in the night effect upon the streets.

The change from one illuminant to the other, which has gradually progressed, is much less marked in cities provided with flaming-arc or magnetite-arc lamps than elsewhere. In some instances—for example, in Hartford—the 4-amp magnetite lamp has been replaced by the gas-filled incandescent lamp, but with a tendency toward maintaining a somewhat closer spacing than with the old arc lamps so far as such a change is practicable. Where the more powerful magnetite units of the ordinary or the boulevard type are in use, the substitution of incandescent lamps becomes a more difficult matter despite the advantage gained by the incandescent lamp in not requiring direct current for its operation. This advantage, indeed, is somewhat nullified by the requirement of operation of the incandescent lamps at high current by means of auto-transformers if their highest efficiency is to be attained. And while by this means the use of rectifiers is obvious the auto-transformer certainly does not improve the power-factor, nor does it avoid the use of constant-current transformers with their heavy inductive effect and somewhat modest efficiency save at full load.

All the older arc lamps can be, of course, replaced, lamp for lamp, by high-power incandescent units with an increase in illumination and the advantage of great steadiness; but such a substitution may not be wise in view of the very poor lighting midway between lamps found in American practice. We are very strongly inclined to the opinion that it is undesirable merely to substitute lamp for lamp in the fashion now too often undertaken in replacing, for example, a series of 6.6-amp arc lamps by incandescents giving a somewhat greater candle-power. There may be a small decrement in cost of lighting, but there is no such improvement as the valuable properties of the gas-filled lamp make possible. A street with intolerable illumination is converted by such substitution, at a meager saving, into a street with bad illumination. Such a change ought not to satisfy the public in these days of rapid improvement in street lighting. If the nitrogen-filled lamp is good for anything in replacing the rank and file of old and bad arc lamps, it is certainly worth enough to make a revolutionary change in the lighting conditions, such a change as is grievously needed in most of our cities. Gas-filled lamps in almost all convenient sizes are now available, and there is no reason why they should not be used for all they are worth in improving conditions known to be bad. For instance, it is not uncommon to find arc lamps, and poor ones at that, spaced 300 ft. apart in a city progressive enough and wealthy enough to enjoy good lighting. The time for signing a new contract brings forward an opportunity for going beyond the short-sighted economy of skimping a few dollars out of public lighting, and giving some real illumination on the streets by using, say, 400-cp lamps spaced 150 ft. apart instead of 600-cp lamps placed at the old 300-ft. distance. There has never before been so excellent an opportunity to utilize lamps of moderate power in such wise as to gain the most from them, and now that the opportunity is here it ought to be vigorously improved. The path of progress lies not in replacing a poor arc lamp by a somewhat better incandescent unit, but in making radical improvement in the lighting of the street by changing the spacing as well as the illuminant.

Sinusoidal Voltage from Alternators

There was a time, not many years ago, when it was considered highly desirable to design alternators for the production of relatively flat waves of emf, in order to reduce the maximum flux density developed in transformers connected thereto, and thus to diminish somewhat the loss of energy in hysteresis. It has now come to be recognized, however, that the advantage gained by such diminution in hysteretic loss is more than parted with, in other directions, by the use of distorted emf waves. Designers now seek to produce as nearly sinusoidal waves as are readily practicable. In the *Elektrotechnische Zeitschrift* there appeared recently an article by Mr. W. Seemann in which means are discussed for modifying the wave-form. A relatively simple plan is to use a distributed field winding on the rotor, and to cut away the face of the core of the latter in such a manner as may be experimentally shown desirable, in order to change the local air-gap reluctance. In this manner the stator laminated surface remains cylindrical, but the rotor surface is made somewhat irregular. It would be interesting to have oscillographs presented for such doctored rotors, showing the wave-forms before and after treatment.

Radiant Energy and Cataract

The disorder of the crystalline lens in the eye known as cataract is by no means rare. It is found in men and in other animals. It is ordinarily of slow growth, complete blindness supervening many months after the onset of the first noticeable cloudiness of vision. In his article in this issue Prof. W. E. Burge describes some interesting experiments made upon crystalline lenses removed from the eyes of animals under various exposures to intense radiation. The results tend to show that the normal lens is not liable to be injured by light of any reasonable intensity, either within the spectrum or beyond it. Under abnormal conditions of body nutrition, however, substances which are ordinarily excluded may find their way into the liquids of the eye, and these are capable of disturbing the structure of the lens, especially under the influence of powerful light.

The tendency to the development of cataract is probably more marked in tropical countries than in temperate climates. Thus, cataract is seemingly more common in India and central Africa than in Europe or North America. If this tropical preponderance is borne out by statistics, it may be accounted for by the greater intensity of solar illumination, which, while inactive when the body is healthy, becomes a source of danger during periods of malnutrition.

LETTERS TO THE EDITOR

The Audion Telephone Repeater

To the Editor of the ELECTRICAL WORLD:

SIR:—At the close of the article on the "Inauguration of Transcontinental Telephony" in your columns for Jan. 30, 1915, you state: "This result could have been achieved only by means of relays, to which beyond doubt much of the success of the long-distance telephonic transmission must be attributed." In this statement you are perfectly correct. The transcontinental service would have remained an impossibility, as it was for ten years after the purchase by the Bell telephone interests of the rights to the Pupin loading coil, had it not been for the use by the American Telephone & Telegraph Company of the De Forest "Audion" amplifier as a telephone relay.

Licenses to operate under the fourteen United States patents on the audion and amplifier were purchased in 1913 by the American Telephone & Telegraph Company following a demonstration during the preceding year by Dr. Lee de Forest before the engineers of the Western Electric Company of the amplifier as a telephone repeater. Within two years thereafter telephone service between New York and San Francisco was opened to the public.

To-day there are three audion repeater stations in the transcontinental telephone line, the pivotal one being at Denver, Col. At the demonstration theater, Liberal Arts Palace, Panama-Pacific International Exposition, are connected some 150 telephone receivers, in any one of which the voice of the speaker in New York is heard actually louder than in ordinary city telephone service. The diffused music of a gramophone played in New York can be heard throughout the small theater in San Francisco.

While withholding no iota of credit due the masterful engineering skill involved in the design and construction of this epoch-making line, the fact remains that it would have been labor lost were it not for the audion amplifier. For a generation telephone engineers had sought in vain to solve the repeater problem. It would hardly be exaggeration to state that hundreds of forms of repeaters had been suggested, tried and found wanting by the telephone companies. The majority of these attempts dealt with the old telephone receiver—carbon microphone combination, in an endless variety of forms. The methods employed were always mechanical and invariably failed. If sufficiently sensitive such repeaters required continual adjustments by experts. Temperature changes upset the delicate balance of parts. Moreover, these devices "packed" or "fried," or were horribly microphonic, when adjusted to amplify sufficiently. As a matter of course, such a telephone repeater failed to perform the inconceivably difficult and delicate task asked of it—where current changes representing a fraction of a microwatt were required to push and heave pieces of iron and lumps of carbon.

Dr. de Forest chose rather to deal with "ions," gas atoms or sub-atoms—matter in its most tenuous form—styled by Professor Crookes the "fourth state of matter."

Imagine one of the ionic carriers of the voice currents or electric charges, and contrast it with a carbon-granule of a microphone transmitter of the early "telephone relays." Compare a soapbubble with a load of coal, and you will have some relative idea of the difference between the delicacy and elegance of the audion and that of the old microphone relay.

It is only fair then to point to the audion amplifier as a device in a class distinctly alone—epoch making in wire telephony as it is in radio signaling.

F. M. WILLIAMSON,
New York, N. Y. *President De Forest Radio Telephone & Telegraph Company.*

Diminutive Motor

To the Editor of the ELECTRICAL WORLD:

SIR:—One of our students in electrical engineering, Mr. H. F. Keeler, has been successful in building a motor of such diminutive size that we consider it to be the smallest motor in the world. Perhaps you might find the specifications and inclosed photograph of sufficient interest to give them space in your valuable paper. It is expected that the motor will be exhibited at the Panama-Pacific International Exposition.

The following are the principal specifications of the motor: (a) Series-wound; (b) extreme height, 5/16 in.; (c) diameter of three-part commutator, 7/64 in.; (d)

EXACT SIZE OF MOTOR AND LINCOLN CENT

diameter of the armature, 3/16 in.; (e) diameter of screws which connect armature wires to commutator segments, 1/64 in.; (f) 14 in. of No. 40 B. & S. silk-covered wire on the armature core; (g) 24 in. of No. 40 B. & S. silk-covered wire on the field core; (h) weight of the entire motor, 20 grains. The inclosed photograph shows the motor in front of a Lincoln penny. The diminutive size of this machine is thus made strikingly evident. It runs at such high velocity on two or three cells of small dry batteries that it makes a noise very similar to that of a fly buzzing on a window pane.

ADOLPH SHANE,
Des Moines, Ia. *Dean College of Engineering, Highland Park College.*

Revision of Overhead-Crossing Specifications

To the Editor of the ELECTRICAL WORLD:

SIR:—Referring to the editorial in your issue of March 27 on the national joint committee on overhead and underground line construction, and to the work of the overhead-line committee of the N. E. L. A., permit me, as a member of both committees, to offer a few facts and one or two deductions which may or may not be facts.

You are well within the truth in crediting the old joint committee with the ability to assimilate hard work and punishment, and in some ten years' service on engineering committees I have yet to find one with a better record in that respect.

If, however, the product of the committee was faulty—and the writer does not admit that its faults were in any way connected with the law—the fault is at least equally blamable upon the industry at large. An engineering committee is supposed to receive advice and criticism from those affected by its work or from any-

one having special knowledge of the subject under consideration. Such advice is assumed to be honest and disinterested—although perhaps in error—and when received has always, to the writer's positive knowledge, been given consideration.

For the purpose of acquainting the industry with the fact that advice from various experts was required, apart from the obvious notice of the appointment of such committees, the old committee wrote numerous personal letters and printed and distributed 1000 copies of the preliminary draft of the power wire crossing specifications. If, then, the electrical industry, or the majority of the companies therein, will not take the trouble to assist their own men in the preparation of specifications, it seems, to the writer at least, that subsequent complaints are made with a very bad grace.

With your suggestion of several grades of construction the writer is and has always been in accord. But, although such a specification is good engineering and good common sense, it has been claimed that it is not good law.

It would seem that in your editorial, in common with the general public, you confuse the intent of the use of the word "voltage" as a descriptive limitation. Such usage is not predicated upon the voltage as such, but upon the fact that the details of construction and the general nature of lines group themselves roughly in classes according to the voltage. Another word or concise characterization is much to be desired, but we still await it.

In conclusion, may I suggest that you cannot do a greater service to the industry than to open your columns at this time to a country-wide discussion of the proper requirements of a general national power-wire crossing specification?

New York, N. Y. R. D. COOMBS.

Evaluating the Isolated Plant

To the Editor of the ELECTRICAL WORLD:

SIR:—Your editorial on evaluating the isolated plant in the issue for March 13 touches upon a point of practical value in which I have taken much interest.

The value of money invested in the installation of machinery for the generation of energy is an element rarely considered by the owner of industrial establishments or of business and other buildings.

Your remarks are particularly pertinent to the two latter classes. It must be admitted that there are various operations in connection with an industrial process which may be productive of a less rate of return than the actual process of production in which a factory is engaged but which would be justified, even with a monetary loss, if their effect should be to facilitate the output of the product.

But wherever such an operation can be conducted by exterior means which do not involve the outlay of capital it seems proper that the value of money to the industry carried on should be considered as a charge upon the operations. In the case of large industries possessing ample credit that value may be merely the average borrowing rate, or the rate at which bonds or stock can be placed at par. But even if the money invested in a plant should be secured by a special borrowing at a lower rate of interest than other capital invested in the general business is earning, part of the productive capacity of the business is being diverted to the purpose of finding that interest.

But in the case of city buildings where the investment is made upon building construction for the purpose of a revenue thereon, it seems that the diversion of money from building construction to the installation of machinery, and to the construction of part of the structure for the purpose of housing the machinery, displaces earning capacity, and the process is chargeable with the full rate of revenue obtainable from the use of the money in revenue-earning space.

As an isolated plant is not a source of revenue and produces no direct return for the capital invested in it, the investment becomes an encumbrance upon other capital invested in the business or building, which is money-earning. If it is not charged fully to the plant, and interest debited thereto, the deficiency must be charged against and be carried by other parts of the industry or business.

There is some portion of any commercial building (such as an office or apartment building) which has been constructed for and serves no other purpose than the earning of the money required to pay the interest upon the cost of the power plant and of the space which it occupies.

New York, N. Y. REGINALD PELHAM BOLTON.

Measurement of Flue-Gas Temperature

To the Editor of the ELECTRICAL WORLD:

SIR:—In the March 6, 1915, issue of the ELECTRICAL WORLD there appeared a short article in which it was stated that the cutting off of a boiler baffle reduced the flue-gas temperatures in a boiler from 625 deg. to 575 deg. Fahr. Such a reduction of temperature is very doubtful, as the measurement of the true temperature of flue gases is one of the most difficult operations connected with boiler testing. According to the published researches of the United States Bureau of Mines, flue-gas temperatures as generally measured with a mercury thermometer are from 30 deg. to 100 deg. low, the amount of the error being dependent upon the location of the thermometer. This difference between the actual and measured temperatures is accounted for by the radiation from the thermometer to nearby objects such as the relatively cold boiler surfaces, the setting, etc.

For a black body the amount of heat radiated is expressed by Stefan's law, that the energy radiated is proportional to the difference in the fourth powers of the absolute temperatures of the hot and cold bodies. A thermometer when used to measure flue-gas temperatures radiates under approximately black-body conditions and attains a temperature at which the heat absorption from the gas equals the loss by radiation and conduction along the stem. If the thermometer is in a current of gas moving at high velocity, heat is carried to the thermometer at a higher rate than if the gas velocity is low. From a consideration of the above law of radiation, it is evident that the temperature indicated in the first case will be higher than in the second, although the actual temperatures of the gas may be the same in both cases.

The article referred to above does not state the location of the thermometer used to measure the flue-gas temperatures, but from the above it is evident that if it was placed in the current of gas passing the extremity of the baffle the lower temperature recorded after cutting off the baffle can be accounted for by the lowered velocity of the gases. The reduction in "draft" resistance due to cutting off the baffle would also tend to cause a larger volume of air to pass through the fuel bed and result in a lower flue-gas temperature for the same rate of coal combustion. This condition could be detected by a comparison of the flue-gas analyses before and after cutting the baffle.

Washington, D. C. FRANK T. LEILICH.

STORM TIES UP TRANSMISSION SYSTEMS

Wind and Sleet Sweep the Atlantic Seaboard and Damage Overhead Lines in North Carolina

A heavy and unseasonable snowstorm started off the Florida coast Friday, April 2, and swept along the Atlantic seaboard, reaching the Middle Atlantic and New England States on Saturday. It was accompanied by high winds, but, while it did considerable damage to telegraph and telephone lines all along the coast and seriously handicapped railway traffic, the lighting companies apparently were not greatly inconvenienced except in the State of North Carolina, where the fury of the storm was greatest. Shipping suffered most off the Virginia and North Carolina coast.

In the eastern half of North Carolina the transmission system of the Carolina Power & Light Company was practically paralyzed. The unusual atmospheric conditions for that section were such as to make possible the greatest destruction to transmission lines from extreme ice loading and wind pressure. The heavy fall of snow (15 in. to 16 in.) was preceded by a rain which, combined with freezing temperature and a wind velocity varying from 18 to 30 miles an hour, loaded all lines with a frozen coating of snow in a semi-ice condition that increased the diameter of the larger wires, it is said, to about 6 in. and put poles and towers under severe stress. The extra weight and wind pressure brought down the majority of the telephone and telegraph lines in about six hours. The wood-pole transmission lines from the company's substations were also down by Saturday morning, April 3, and the steel tower lines were put out of commission by the twisting and buckling of a number of towers.

The company's line crew was set to work in the city of Raleigh, N. C., as soon as the storm subsided Saturday morning, and by 11 o'clock Saturday the commercial district was cleared of poles and work was begun on temporary circuits for lighting. By order of the Mayor, however, lighting service was not established on account of possible fire and life hazard until 6.30 Sunday night. Lighting service was not established in the residential districts until Monday and Tuesday. The street-car system was placed in operation about noon Sunday. Linemen were set at work cutting trees for poles and constructing temporary lines to permit the operation of mills and industrial establishments served by the Carolina Power & Light Company. Every effort was exerted to secure and organize line crews so as to rush this work, all nearby cities being drawn upon and the different power companies of the South lending aid and all the linemen they could spare. A gang of sixty experienced linemen left Atlanta on Tuesday. These men were secured from Birmingham, Macon, Chattanooga and Atlanta.

The district most affected by the storm was that served largely by the Carolina Power & Light Company from the Blewett Falls plant of the Yadkin River Power Company, on the Pee Dee River, and the Buck Horn plant of the former company, on the Cape Fear River. The two-circuit, 96-mile tower line from the Blewett Falls plant to the main substation at Method and the 34-mile tower line from the Buck Horn plant to a tie-in station near Raleigh, as well as the tower tie-line between this point and the Method substation, were put out of commission. The tower line from the Method substation to Durham, where a physical connection is made with the Southern Power Company, was also out of commission. The Greensboro-Durham line of the Southern Power Company suffered considerable damage. The steel towers failed because of buckling near the ground and from twisting, the extent of failure depending on the kind of loading and direction of strain.

Temporary repairs were at once made on the main two-circuit, 110,000-volt tower line from the Blewett Falls station to the Method substation, and this line was placed in operation early in the week. Auxiliary steam stations at Henderson, Goldsboro and Raleigh have been pressed into service until the lines from the water-power stations are in operation. The street railway and lighting systems of the Durham (N. C.) Traction Company were out of service Saturday and Sunday.

The tower and pole lines disabled by the storm in North Carolina include a two-circuit, 110,000-volt steel-tower line from the Blewett Falls station to the Method substation, a two-circuit tower line from Blewett Falls to Hamlet, a single-circuit line from the latter place to Lumberton, a single-circuit, 60,000-volt tower line from the Buckhorn station to the tie-in station near Raleigh, and the tie-in tower line between this station and the Method substation. A wood-pole line from Method to Roxboro, which supplies Franklinton, Henderson, Oxford and Roxboro, had its poles and wires thrown to the ground, except on a new section completed in January of this year, between Oxford and Roxboro. The pole line from Method to Goldsboro, supplying Clayton, Selma, Smithfield and Pine Level, was also in bad condition with poles and wires down.

It was estimated that service could be restored by a temporary means so as to permit the operation of practically all cotton mills and other plants during the next week, while the reconstruction of the transmission lines will take about three months. About 450 miles of both high-tension and low-tension lines were affected and will require repairs.

MISHAP TO SEATTLE MUNICIPAL PLANT

Failure of Two Wooden Penstocks Causes Shutdown of Cedar Falls Power Plant—Load Carried by Steam Reserve Station in Seattle

The hydroelectric generating station of the city of Seattle on the Cedar River was put out of commission Tuesday afternoon owing to the failure of the wooden-pipe lines. Both of the 4-ft. and 6-ft. penstocks were carried away at a point below the crib dam where a somewhat similar accident in the spring of 1911 tied up the municipal system completely. At that time the crib dam was carried away by high water and the municipal load was carried by the Seattle Electric Company, a Stone & Webster property.

The accident on Tuesday was first discovered by quantities of gravel being shot into the turbines. Heavy rains caused an unusual volume of water in the Cedar River to undermine the foundations of the wooden penstocks which are laid partly in the river valley. Superintendent Ross of the city lighting department attributed the accident to high water and the age of the wooden penstocks. Temporary repairs will be made in a few days, the municipal lighting load meanwhile being transferred to the new 7500-kw auxiliary steam station (ELECTRICAL WORLD, Jan. 9, 1915) and to the small hydroelectric station at Lake Union which utilizes the overflow from the Volunteer Park reservoir of the city water department. This station is rated at 1500 kw and the turbine operates under a 400-ft. head.

The Cedar Falls station of the city of Seattle was described in detail in the ELECTRICAL WORLD for June 1, 1912.

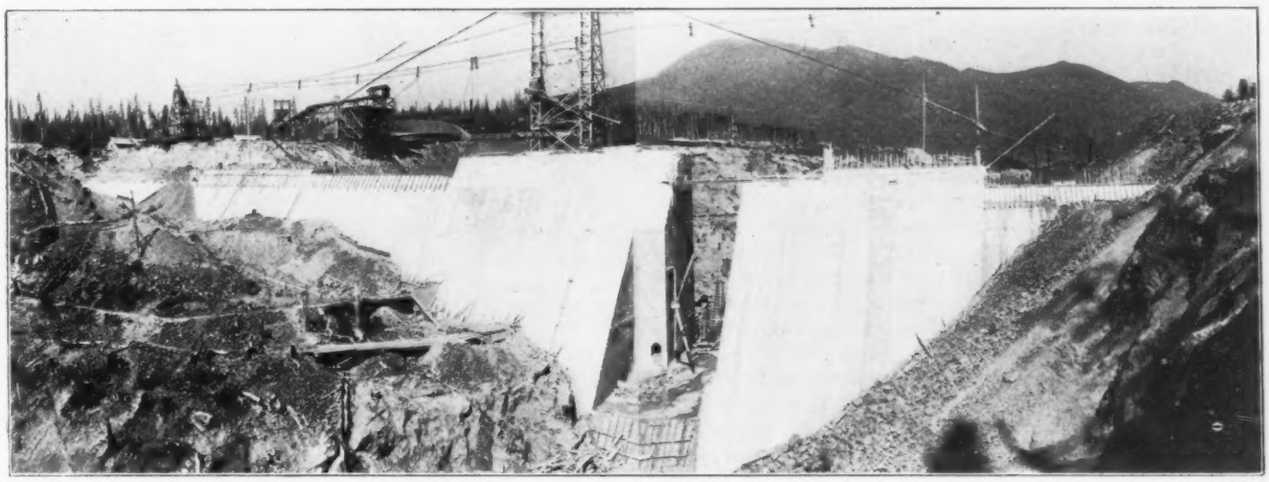
The source of energy is the water in Cedar River, a mountain stream which rises in the Cascades and flows into Lake Washington, which has its outlet into Puget Sound at Seattle. Water is stored for the power plant

in Cedar Lake, a mountain lake about 3 miles long and 0.75 mile wide, lying at a natural elevation of 1530 ft. above sea level. At the point where the river flows from the lake the city erected in 1902 a small wood crib dam, which raises the level of the lake to an elevation of 1546 ft., and three or four more feet is obtained by the use of flashboards.

From this dam two wood-stave pipes lead down to the power house 3½ miles distant and 600 ft. lower in elevation. The first pipe, built in 1904, is 49 in. inside diameter, of thirty staves cut from 2-in. by 6-in. stock. The second pipe, built in 1908, is 67¾ in. inside, of thirty staves cut from 2½-in. by 8-in. stock. Both pipes are laid on benches cut in the side of the canyon. The bands are of wrought iron, designed with a factor of safety of four. The highest head under which the wood-stave pipe operates is 310 ft., and the sharpest curve is 18 deg. Where it was necessary to turn with a shorter radius, riveted-steel elbows of 15-ft. radius were inserted. The smaller pipe connects to a 48-in. riveted steel pipe at a point 1008 ft. from the power house. The total length of the wood-stave pipe in this line is 15,407 ft., making the total length of the line 16,415 ft. At a point 951 ft. from the power house the larger pipe branches through a Y-connection and two 48-in. valves into two 48-in. riveted pipes. The steel pipe varies from ⅜ in. to 11/16 in. in thickness. At the power house a cross-connection with valves is arranged so that any one of the three pipes may be used on any of the machines, and the valves are normally left open to equalize the pressures in the three pipes. A 30-in. wood-stave standpipe is placed on each pipe at a point 3600 ft. from the power house. These pipes are 65 ft. and 70 ft. in height respectively on the smaller and larger pipe and serve to decrease the effect of water ram and better the regulation. Smaller standpipes and air valves are placed at frequent intervals along each line.

The wood crib dam permitted a maximum variation in the lake's elevation of less than 20 ft., which affords approximately 1,000,000,000 cu. ft. of storage. With this amount of storage a great deal of water was wasted during the rainy season. It is estimated that approximately 7,000,000,000 cu. ft. of storage is sufficient to conserve the entire run-off of the watershed for power generation.

Recently a new concrete dam 215 ft. high has been built, at a cost of $1,400,000. This dam will raise the lake from its present level of 1550 ft. to 1590 ft. and provide enough storage so that the entire run-off may be used for power. An ultimate development of 40,000 kw is planned; 13,500 kw is now installed. The new water-wheels will be of the impulse type with two overhung wheels driving one 10,000-kw generator. The impulse wheel is preferred for this head, 600 ft., after experience with both impulse wheels and turbines, on account of its simplicity and the fact that it can be taken apart and repaired between the daily peaks. The wheels will be equipped with needle nozzles with by-pass arranged to eliminate water ram on the penstocks. The double-wheel and needle-nozzle arrangement also gives high efficiency through a wide range of load, and this efficiency is well sustained through the life of the wheel. All-steel penstocks are to be used in preference to the cheaper wood on account of the greater reliability of the steel in service, which far outweighs considerations of economy. The Cedar River plant was taxed to capacity during the winter of 1913-14, and it was to help over the peaks of the past winter that the steam auxiliary was rushed to completion. Mr. J. D. Ross is superintendent of lighting in charge of the Seattle Municipal System.



NEW DAM ACROSS CEDAR RIVER FOR SEATTLE MUNICIPAL HYDROELECTRIC PLANT

Capitalization of Boston Welfare Improvements Denied

In authorizing the issue of $2,048,000 additional stock by the Edison Electric Illuminating Company of Boston at 215, the Board of Gas & Electric Light Commissioners expressed unwillingness to allow the capitalization of certain improvements, such as those for welfare buildings, which do not constitute property of a character directly productive of revenue.

The case was complicated somewhat by the question relative to the capitalization of expenditures for certain items in the nature of alterations of existing property adding little or nothing to value, or relative to work upon customers' premises rendered necessary by changes in the conditions of service. Other items were for automobiles, horses, wagons, signs, furniture, etc., for which the board has not heretofore approved stock, and certain other expenditures related to the so-called "welfare buildings" of the company at its Massachusetts Avenue property, Boston.

The commission states that while realizing the burden upon a company's working capital of the initial cost of such equipment as automobiles, renewals must be provided for so promptly and are recurrent so regularly that the board believes such renewals may properly find their way directly into operating accounts. With

regard to the welfare buildings, the commission says: "The board sympathizes with every humane effort of a company in behalf of its employees, and recognizes that its extent must depend upon circumstances not readily defined. But when directed beyond suitable provision for the health and safety of the employees and if so substantial in amount as to tend to add an extra burden to the consumer or to take from the stockholder the full measure of his right to a fair return, the representation of such expenditures in permanent capital becomes of doubtful propriety."

The board therefore determined that $3,500,000 represented in the promissory notes of $5,640,000 outstanding on Jan. 1, 1915, may be capitalized, and does not permit the company to capitalize the expenditure for the welfare buildings or other specific items.

Service Interruption in Chicago

Governor trouble developing on one of the 15,000-kw sixty-cycle turbines in the Quarry Street station of the Commonwealth Edison Company, Chicago, at 6 o'clock Wednesday morning shut down the company's sixty-cycle system, the load on which at this early morning hour amounted to only 11,000 kw and was being carried by the one turbine. A small part of this output was being fed through a 500-kw motor-generator set to the down-town direct-current system. As the turbine slowed down the motor-generator was back-fed with energy from the direct-current network, which receives its supply from batteries and other substations. The motor-generator was finally freed, however, by the blowing of fuses on the positive mains and feeders, thereby interrupting the service to several city blocks. On the sixty-cycle system the service was restored within an average of two minutes through motor-generator sets in various substations.

Cost of 66,000-Volt Transmission Line

An extended discussion of the cost of a 66,000-volt transmission line was a feature of a recent hearing given by the Massachusetts Gas and Electric Light Commission to the Turners Falls Power & Electric Company, of Greenfield, Mass. The line was built from Turners Falls to Springfield, Mass., and is 42.88 miles long. It is designed for ultimate service at 110,000 volts, and the total cost is shown in the following table:

Clearing right-of-way	$13,898
Contractors' general expense	9,151
Transportation of materials	6,072
Excavation for standard anchors	14,913
Setting standard anchors	10,443
Steel towers	73,526
Assembling and erecting towers	22,861
Insulators installed	20,536
Wire	127,122
Hardware	6,557
Changes in line	6,803
Total	$311,882
Special river crossings	35,218
Special towers at substations	2,627
Special concrete footings	13,057
Grand total	$362,784

The first section above totaled covers the so-called standard construction used on the line and figures $7,296.68 per mile, or $672.16 per tower. The total cost, including special work as listed but not including real estate and right-of-way, was $8,465.11 per mile, or $781.86 per tower.

The line was built by F. T. Ley & Company, Springfield, Mass. The power company bought the material, furnished the towers, wire and insulators, and purchased the right-of-way. The right-of-way is 150 ft. wide and cost about $250 an acre. Since the line was built, about a year ago, the right of eminent domain has been granted to transmission companies in Massachusetts, which would unquestionably have greatly reduced the cost of the right-of-way had it been operative during the preliminary period. Where the line traverses level and fairly firm soil the towers are secured by anchors 7 ft. long with 1-ft. cross-pieces, set in the earth, one anchor being provided at each corner of the tower. At railroad crossings, marshy and wet places the anchors are installed in concrete legs about 2 ft. square and 8 ft. deep, except where the towers are lifted considerably above the ground level. One such concrete footing is used at each leg of an angle tower in crossing the Westfield River, and for 2 miles between the Agawam substation and Springfield. Across this portion of the line the country is flooded from 5 ft. to 15 ft. deep in the spring.

There are three special river crossings, where the towers cost $1,250 apiece at the factory and are 100 ft. high. It cost from $1,000 to $1,200 to erect these on the ground. The foundations cost from $1,800 to $2,500 each for these crossings, except where the line crosses the Connecticut River and enters Springfield. Here the cost was $4,000. Copper-clad steel wire is used on the long spans. The item "contractor's general expense" includes the cost of maintaining camps, transportation of general superintendents, etc. "Changes in line" covered relocations in the field after a portion of the construction was in. From Turners Falls to Amherst heavy timber was encountered. The total cost of the right-of-way was $200,695.

Excluding right-of-way and not including special river crossings and concrete footings, the line cost $7,296.68 per mile, or $672.16 per tower, compared with $8,280 per mile and $900 per tower on similar lines built in the same general territory. The Turners Falls towers weigh about 4000 lb. each, compared with 5700 lb. for the standard towers of an adjacent system. River-crossing towers were built of structural steel and riveted on the job, the standard towers being only bolted together. The neighboring system (Connecticut River Transmission Company) spaces its towers 9.2 per mile and uses No. 00 wire, compared with a spacing of eleven per mile and No. 0 conductor on the Turners Falls system. The former also uses six suspension insulator disks per wire, while the latter employs four, costing $1 per disk. Each tower carries two three-phase circuits, and the standard towers are approximately 75 ft. high and about 17 ft. square at the base. To change the line for 110,000-volt service the only alteration necessary on the line proper will be the addition of insulator disks.

Water-Power Conservation in Massachusetts

In response to a legislative order the Massachusetts Harbor and Land Commission has submitted a report upon the conservation of water resources, asking an appropriation of $25,000 for a thorough investigation of possibilities of conserving, equalizing and utilizing the flow of streams. The report emphasizes the need of codifying the water-power laws and of formulating a policy by the State, which at present is hampered by a divided control of streams by the federal government and various state commissions. Consideration is given to possibilities of regulating the average stream flow by the construction of storage reservoirs, opportunities for energy development on the tributaries of large rivers, and reduction of wasted flow.

Equipment of Large Publishing House

Power Plant, Interior Wiring and Special Features of the Curtis Publishing Company's Building, Independence Square, Philadelphia

THE design of the electrical equipment of a large publishing house is a task of no mean proportions, especially when provision has to be made for growth of business and for possible changes and alterations in existing layout. The home of the Curtis Publishing Company, Philadelphia, Pa., publisher of the *Ladies' Home Journal*, the *Saturday Evening Post* and the *Country Gentleman*, consists of a ten-story publication section and a ten-story manufacturing section connected by a twelve-story convenience belt extending across the entire width of the building. The building contains 14,500,000 cu. ft. Some idea of the magnitude of its electrical installation can be obtained from the fact that the total connected load consists of electric motors having a combined rating of 4000 hp and lamps aggregating a total consumption of 575 kw.

An isolated generating plant is employed for furnishing energy for the numerous motors and lamps throughout the building. An emergency connection with the mains of the Philadelphia Electric Company is provided for automatically furnishing energy to lamps in the power plant, hallways and stairs in case of failure of the main supply. The power plant is situated on the Sansom Street side of the building.

Fuel is stored in a bin placed above the boilers. This bin is constructed of reinforced concrete and is supported by the steelwork of the building. Upon arrival at the power plant the coal is dumped through an iron grating into a scale hopper and weighed. From this hopper the coal passes to one of two motor-driven conveyors which distribute the coal over the bin. The coal then passes from the bottom of the bin into one of two traveling scale hoppers, where it is again weighed and dumped on the floor in front of the desired boiler. No manual handling of the coal is required until it reaches the floor of the boiler room, electric motors and gravity performing all the work. The hoppers previously mentioned provide ample means of weighing and check-weighing all coal consumed in the plant.

The boiler equipment is on the third story of the building. It comprises nine boilers having a combined rating of 3100 boiler-hp, five boilers being placed on one side of the room and four on the other side. Hand firing is employed throughout. A separate fan and engine provide forced draft for each bank, but an independent steam blower is also installed on each boiler for use in case of accident to the fan equipment. Each boiler is fitted with a superheater capable of giving 125 deg. of superheat. A separate chimney leads to the top of the building from each bank of boilers. Two economizers are installed along each side of the boiler room, the arrangement of the chimney flues on each

FIG. 1—EXTERIOR VIEW OF CURTIS BUILDING

side being such that one or both economizers may be thrown out of service at one time. A carbon-dioxide recorder is installed so that readings may be taken in any boiler or in either of the two chimneys.

The ashes are accumulated in metal brick-lined hoppers below each boiler. These hoppers are arranged to discharge into an ash car, which in turn dumps into an ash bin outside the building, whence the ashes are removed by wagons. A separate ash system is provided for each side of the boiler room.

The boiler-feed pumps, heaters, etc., are placed in the ash room, which is below the boiler room. Two steam pumps and one electric pump are installed, one steam pump and the electric pump being sufficient for the entire plant. The other steam pump is for use on Sundays and at other small-load periods. The pumps are equipped with pressure regulators, and the boilers are provided with automatic feed regulators. The feed water is heated by means of two open feed-water heaters, taking exhaust steam from the main exhaust pipe. The feed-water supply is delivered to a feed tank on the boiler-room floor, whence the water flows by gravity to the heaters and thence to the pumps.

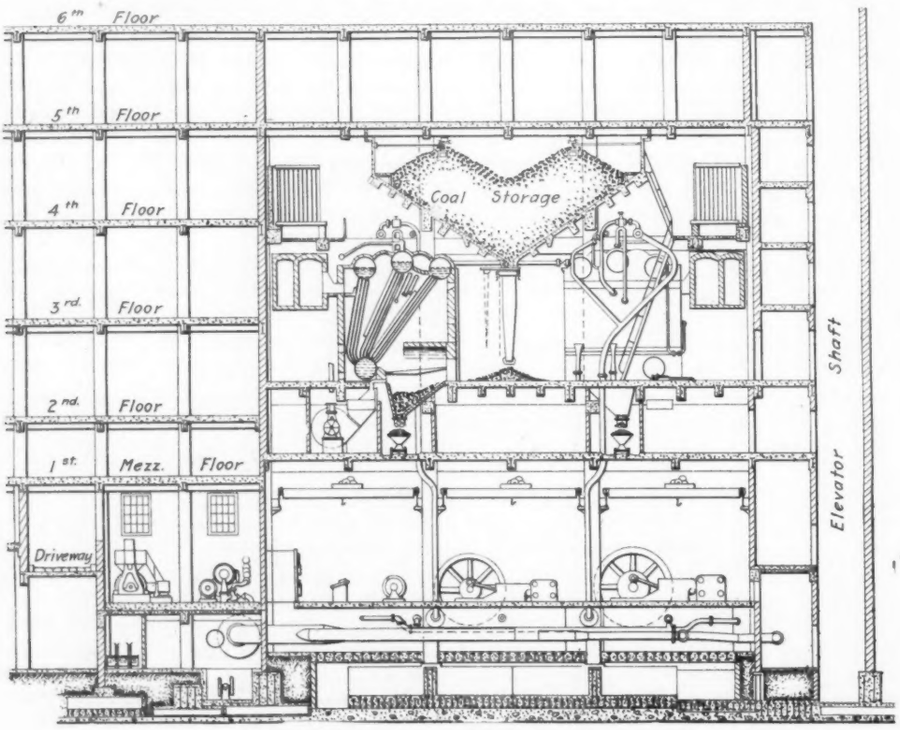


FIG. 2—CROSS-SECTION OF POWER PLANT

The city water supply and the general house supply of the building are both connected to the feed tank at different levels, the former being above the latter. The inlet of water to the tank is controlled by float valves. In cold weather the major part of the feed-water supply is obtained from the water of condensation in the heating system of the building. This water is collected in a tank installed below the basement floor of the building and pumped into the feed tank previously mentioned. The feed pumps are equipped with boiler-compound pump attachments, which deliver the compound into the heaters. An injector of 1800-hp rating is also connected to the feed-water system so as to be capable of feeding any boiler.

Two boiler-feed lines are placed over each row of boilers, each line being connected to both the pumps and the injector system. The feed lines are equipped with the necessary safety valves. A meter with registering and recording attachments measures all feed water delivered to the boilers.

Engines and Generators

The engine room, which is on the first story, contains eight electric generating units, having a total rating of 3600 kw, divided, in order to meet load conditions, into two 200-kw, three 400-kw, one 500-kw and two 750-kw units. Each unit is driven by a cross-compound engine at a speed of 150 r.p.m., the engines being directly connected to the generators, which are all of the direct-current type. A steam pressure of 175 lb. is employed, and all electric energy is generated at 230 volts. Energy at this voltage is used for all motor applications, such as presses, elevators, etc. For lighting purposes energy is furnished at 115 volts by means of a three-wire system and balancer sets.

The engine and generator foundations are built on a slab composed of concrete and steel beams, which rest on walls the foundations of which lie between the foundations of the columns supporting the building. The object of this construction is to prevent vibration being communicated from the engines and generators to the building. This precaution was especially necessary because artists and engravers work on the floors immediately above the engine room. Each bay of the engine room is equipped with an electric traveling crane for handling machinery.

The lubricating oil for the engine and generators is circulated continuously. A storage tank is placed on the boiler-room floor, and a settling tank, filters and pumps are placed in the basement of the pump room. A storage tank for cylinder oil is provided on the boiler-room floor, with connections leading to the cylinder lubricators on all engines and to fountains in the engine room and pump room. All drips and drains lead to a tank in the basement.

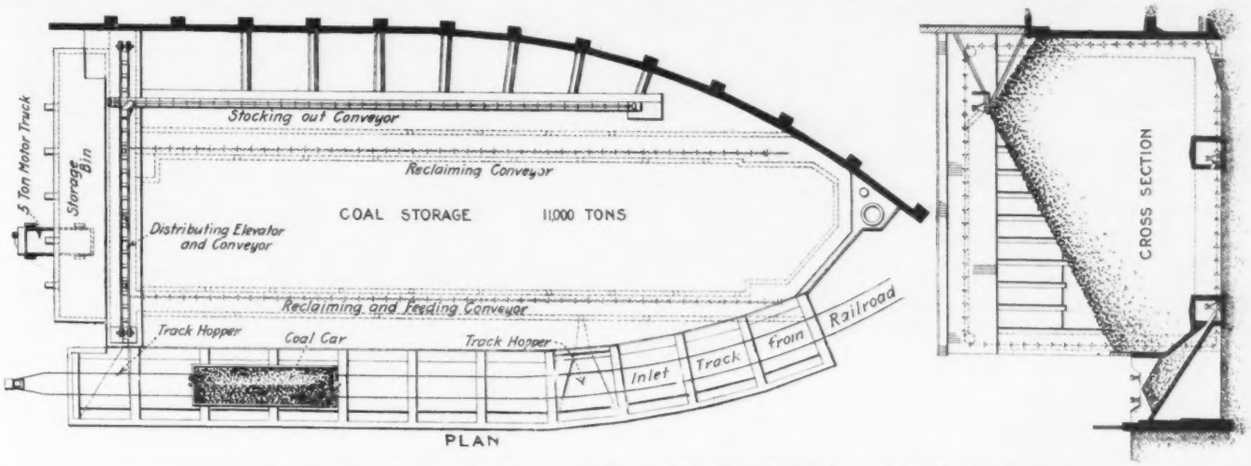
The arrangement of the generator connections and switchboard is said to be one of the finest examples of this class of construction in existence. The main switchboard is placed along one side of the engine room and is 42 ft. long. It is made up of fourteen panels of Tennessee marble mounted on special structural-steel supports. The generators are connected to the switchboard by means of busbars carried in special ducts underneath the engine-room floor. The ducts are closed on all sides by means of slate slabs, as indicated in Fig. 7, the buses resting in channels cut in the alberene-stone insulating members. Instead of placing the main generator switches upon the switchboard they are installed on separate panels near the corresponding generators, and are operated by motors controlled from the bench-board, but in addition they may be manually operated.

Switchboard

Near the middle of the main switchboard is a total-load panel on which are mounted two voltmeters, four ammeters and four watt-hour meters. One of the voltmeters is connected to the two 230-volt buses, while

the other voltmeter is a differential instrument connected to the three-wire buses. One ammeter and one watt-hour meter register the total output of the plant. Another set registers the total energy consumed by motors, while two other sets register the loads on the two sides of the lighting system.

marble benchboard, 14 ft. long and divided into eight panels, each of which controls a single generator. Each of the panels is equipped with two remote-control switches, one for throwing the corresponding motor-operated generator switch in and out and the other for controlling the motor-operated field rheostat. On each



FIGS. 3 AND 4—PLAN AND CROSS-SECTIONAL ELEVATION OF COAL-STORAGE YARD

At the left of the total-load panel are two panels for controlling the balancers. At the left of the balancer panels are the five panels controlling the lighting circuits, while to the right of the total-load panels are the six panels controlling the motor circuits. On each of the latter are mounted six circuit-breakers and six edgewise-type ammeters. The same number of circuit-breakers and ammeters are also provided on each lighting panel, but the ammeters are so connected that by a double-throw switch the current on either side of the three-wire circuit can be measured. Automatic circuit-breakers are installed throughout, knife switches not being used except in connection with the balancers. The circuit-breakers on the 230-volt system are of the two-pole, two-coil type, while the circuit-breakers on the lighting circuits are of the three-pole, three-coil type. The latter are equipped with auxiliary trip coils which automatically open all the lighting breakers in case the balancers go out of operation.

Immediately in front of the main switchboard is a panel is also placed an ammeter for measuring the current output of the corresponding generator. The usual signal lamps are provided to show the conditions of the generator circuits. The adoption of the benchboard permitted the shortening of the main switchboard and at the same time provided the advantage of having the operator in a position to view the entire room when throwing the various generators in and out of service.

Two recording instruments are in the engineer's office, one being an ammeter recording the total load current on the plant, and the other a voltmeter giving a graphic record of the voltage at the main switchboard.

An emergency connection is provided permitting the lamps in the engine room, boiler room, ash room, pump room and on all stairway and fire escapes, as well as a limited number of night lamps distributed throughout the building, to be furnished with energy from the mains of the Philadelphia Electric Company in case of failure of main supply. For this purpose a special switchboard controlling these circuits is employed. This

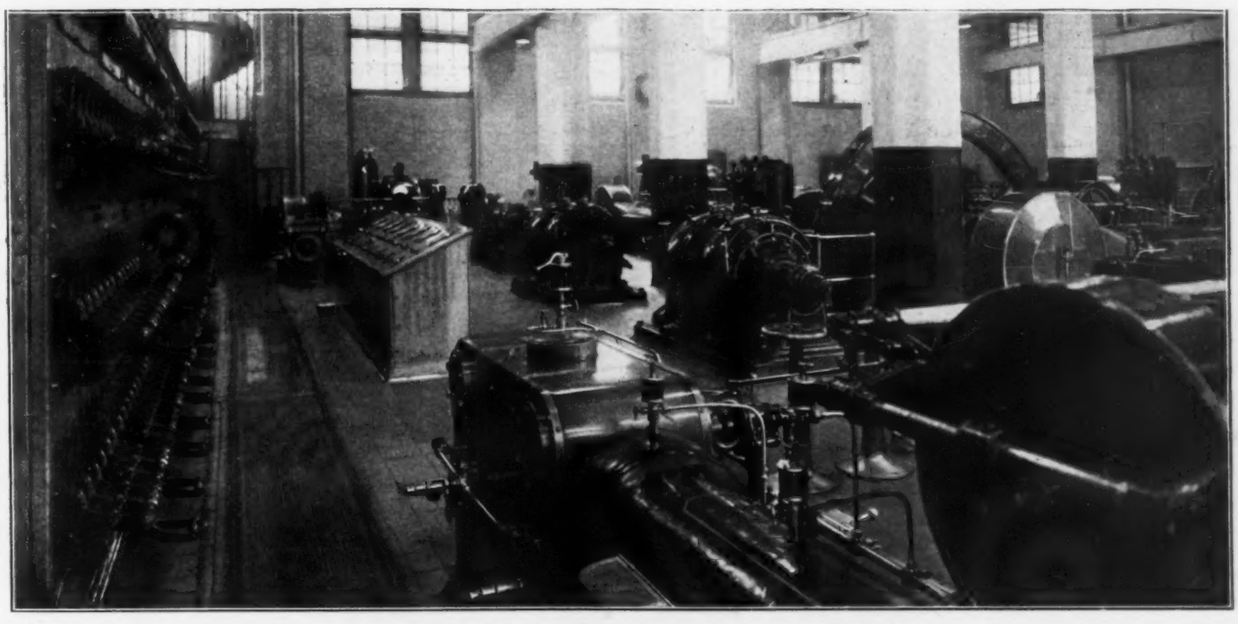


FIG. 5—VIEW OF GENERATING PLANT AND SWITCHBOARD

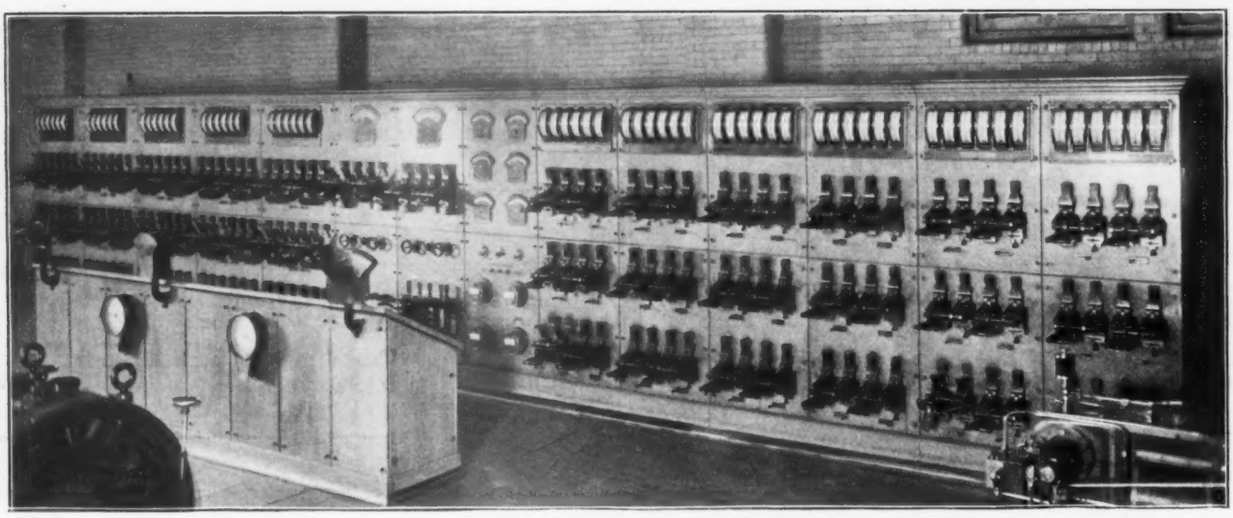


FIG. 6—SWITCHBOARD AND BENCHBOARD

switchboard normally receives its energy from the main switchboard, but if, either accidentally or intentionally, a condition of no voltage should exist on the main switchboard, the main circuit-breaker on the special switchboard opens, causing connections to be made which automatically effect the closing of a motor-operated switch, throwing the Philadelphia Electric Company's service on to the special switchboard. The energy required to throw this switch is obtained from the Philadelphia Electric Company's mains. The circuit-breaker on the main switchboard, which controls the feeder to the special switchboard, is equipped with a reverse-current release which prevents energy from the central-station company's lines flowing back to the buses and generators of the private plant.

Electric Distribution System

Eight wire shafts are employed for carrying the feeder cables from the main switchboard to the various cabinets throughout the building. These wire shafts are constructed with brick walls and fireproof floors and extend the height of the building, being installed at convenient points for distribution, as shown in Fig. 8.

The feeder cables from the main switchboard to the wire shafts are carried in conduits installed on the basement ceiling. The layout of these conduits necessitated at one point the use of a pull box 50 ft. in length.

In the wire shafts the feeders are carried vertically without the use of conduit, being fastened at intervals by means of cable clamps. The cables terminate at feeder panels installed at the various floors in each of the wire shafts. Some of the wire shafts are devoted entirely to lamp feeders and some entirely to motor feeders, while others contain feeders of both types. One motor feeder generally serves only its share of one floor and one lamp feeder generally serves its proportion of two floors, but in several cases a motor feeder serves more than one floor and a lamp feeder supplies only a part of one floor, or another supplies its share of three or more floors. There are more than 12 miles of feeder cables extending from the main switchboard to the main panelboards, exclusive of the distributing submains in the various stories.

From the feeder panels in these wire shafts submains are carried in conduit to the branch panelboards installed at convenient centers of distribution on each story. Where the lamps are controlled only from these branch panelboards the panels are of the push-button type, otherwise the lamps are controlled by push-button switches on walls and columns, or by keys on the fixtures. Where branch circuits are controlled from branch panels, the panels are constructed in two sections, the upper section being for the fuses and the lower section for the push-button switches. The upper section containing the fuses is kept locked, thus preventing tampering with the fuses by irresponsible persons and also preventing a person, when turning on or off lamps, from coming in contact with any exposed energy-carrying parts. In cases where circuits are controlled from the shaft panels Sundh remote-control switches are used.

Those branch circuits which supply energy to the various motors throughout the building terminate at special control panels adapted to the requirements of the service.

The location and number of feeder panels were determined to a certain extent by the fact that it was desired to meter the energy consumed by each department of the company. The watt-hour meters are mounted in the various wire shafts at certain stories and are connected to the feeders or to the sub-mains, thus enabling each department to be charged with its proper share of the cost of producing electrical energy.

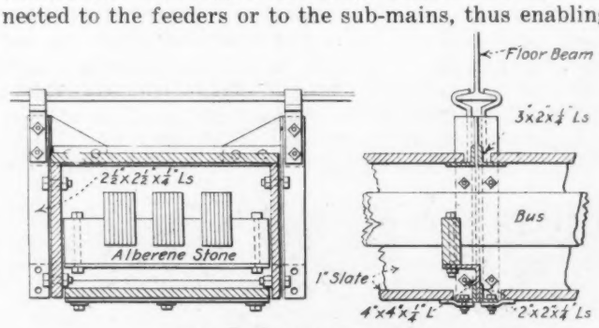


FIG. 7—BUSBAR SUPPORT

The shaft panels are placed in rooms which are accessible through doors that are normally kept closed. These rooms are provided with concrete floors, and special means had therefore to be devised for carrying the riser cables through these floors. For this purpose collars are employed, as shown in Fig. 10. These collars are made from channel-iron frames and are fitted with a 4-in. oak and a 2-in. slate slab, the latter being on top of the former. Holes are provided in these plates for permitting the cables to pass through them. The cable clamps rest upon the slate slabs.

Figs. 11 and 12 show respectively the conduit and wire layouts for a section of the sixth floor of the publication building, that is, the section of the building devoted to editorial and clerical offices. It will be noticed that a number of blank lamp outlets and blank

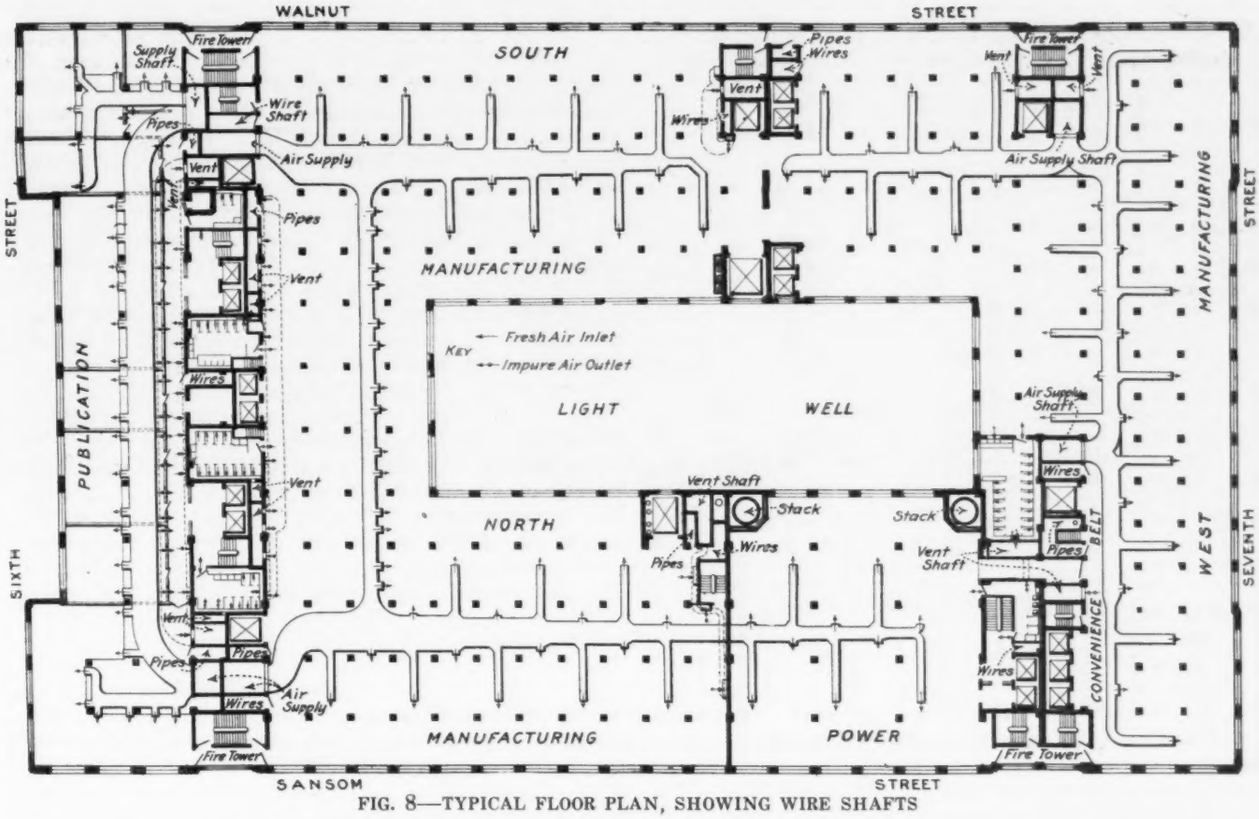


FIG. 8—TYPICAL FLOOR PLAN, SHOWING WIRE SHAFTS

wall-switch outlets are provided, being covered with brass plates. A gridiron system of conduits and the looping together of all switch outlets permits the original installation to be changed to a considerable degree as future needs and the moving of partition walls may necessitate, without requiring the use of metal molding or exposed conduit. At the present time only a portion of the lamp and switch outlets are used, as indicated in Fig. 12.

Plowed floor sleepers and trenches (Fig. 13), the location of which is indicated by brass tacks placed at intervals, are provided in all editorial and clerical departments for allowing concealed connections for telephones, call bells, etc., to be made at any time.

FIG. 9—PRESSROOM, SHOWING MOTORS AND CONTROLLERS

In the manufacturing portion of the building—that is, the portion devoted to the type-setting machines, printing presses, binders, etc.—much exposed conduit

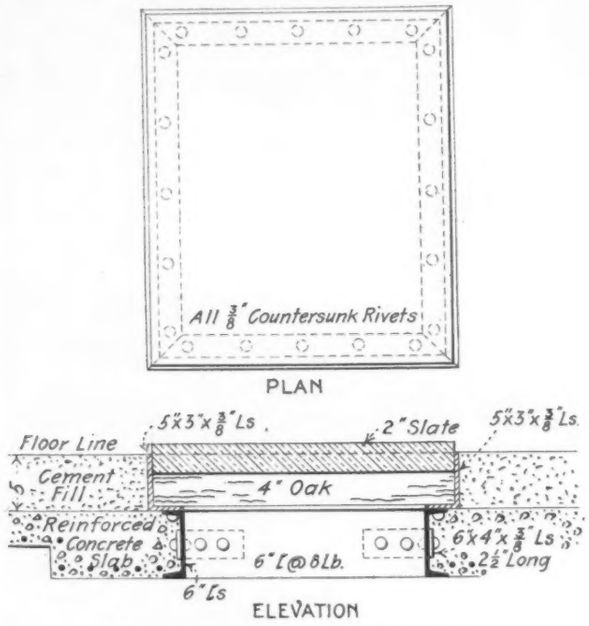


FIG. 10—DETAIL OF FLOOR COLLAR

and metal-molding work is used. All machines in this portion of the building are operated by independent electric motors with push-button control.

The illumination throughout the building varies according to requirements and local conditions. The main reception room is illuminated by semi-indirect fixtures mounted on pedestals, no ceiling lamps being employed. In the clerical and editorial departments semi-indirect or indirect illumination is employed in most cases. In the manufacturing department various types of lamps and fixtures are employed depending upon what usage showed to be the best in each case. In the girls' dining room a number of Parish wall paintings can be artificially illuminated and the correct color tones brought out by means of gas-filled lamps mounted behind lenses in a concrete beam in the ceiling running parallel to the wall containing the paintings. These lamps are all controlled from one wall switch.

An elaborate heating and ventilating system involving the use of a combination of a direct and an indirect steam-heating system is employed. The indirect system performs the double service of supplying heat and fresh air and is in continuous operation during cold weather. The temperature of this heated air is constant and is controlled by thermostats governing the supply of steam to the heating coils. Air for this system is drawn from above the building by eight electric-motor-operated fans installed in the roof houses and having a combined capacity of 564,000 cu. ft. per minute. The air is delivered throughout the building in galvanized-iron ducts. Thirteen exhaust fans operated by electric motors and having a combined capacity of 550,000 cu. ft. per minute are also installed in the roof houses to increase the ventilating effect. The air supply, before entering the fans, passes through an atomized water spray, and finally through the heating coils proper to the fans.

The direct steam-heating system is only in service when the indirect system does not supply sufficient heat, as in the case of extremely cold weather. This system is under thermostatic control in each room. Exhaust steam from the engines in the power plant is normally used for both systems, but this supply may be supple-

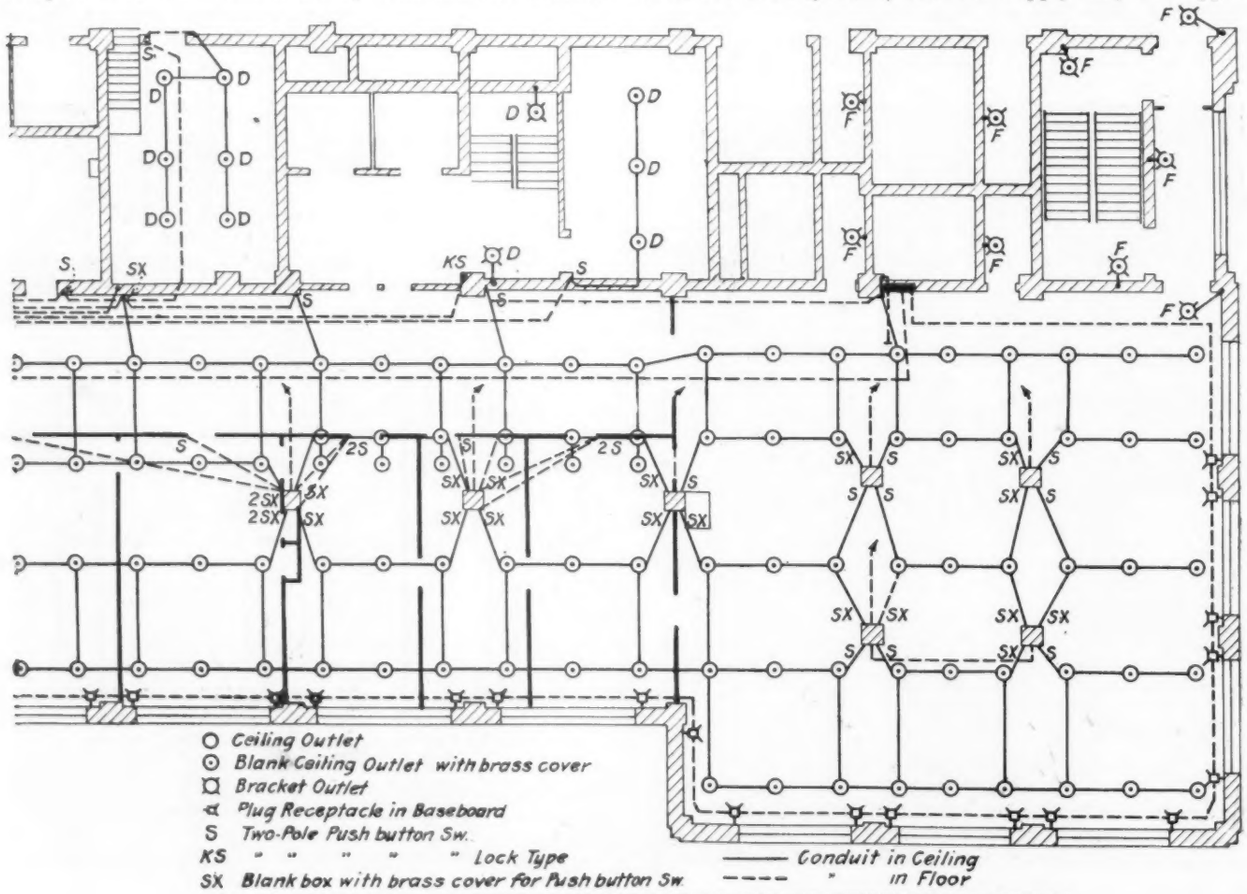

O Ceiling Outlet
⊙ Blank Ceiling Outlet with brass cover
Bracket Outlet
Plug Receptacle in Baseboard
S Two-Pole Push button Sw.
KS " " " " " Lock Type
SX Blank box with brass cover for Push button Sw.
Conduit in Ceiling
" in Floor

FIG. 11—PORTION OF CONDUIT PLAN FOR SIXTH FLOOR OF PUBLICATION BUILDING

mented by live steam in extremely cold weather. The water of condensation from both systems is led by return mains to a receiver in the basement, whence it is pumped under automatic control to the boiler feedwater tank. An independent vacuum system is installed whereby the air is removed from the radiators through valves which automatically close in the presence of steam.

A separate system of exhaust fans is provided for the ventilation of the toilet rooms, which ventilation is accomplished by air being drawn from other portions of the building into these rooms and then through a series of openings into vertical shafts leading to the exhaust fans.

Among the other house machinery which is electric-motor-driven are the fourteen passenger and nine freight elevators, a vacuum-cleaning system, a pneumatic-tube system, magazine conveyors, mail distributers, mail-bag elevators, conveyors, etc., paper-trimming exhaust system, automatic house pumps, refrigerating pumps, and the air compressors for the elevator-door closers and for engine-room cleaning purposes and similar uses throughout the building.

Fire Protection

Although the building is of fireproof construction, it is equipped with four fireproof stair towers. A complete fire-alarm system, including alarm boxes turning in an alarm to the city fire headquarters and to the fire marshal in the building, alarm bells, annunciators and recall bells, has been installed. The electrical equipment is such that when an alarm of fire comes in its location is given on every floor of the building by the illumination on every annunciator of the number corresponding to the floor on which the fire occurs. The alarm bells are installed above the annunciators and the recall bells are installed at various convenient points.

The Curtis Building was designed by Frank C. Roberts & Company and Edgar V. Seeler, architects and engineers, and erected under their supervision by Doyle & Company, general contractors. The power plant and equipment was designed by and erected under the supervision of Frank C. Roberts & Company, engineers, of Philadelphia.

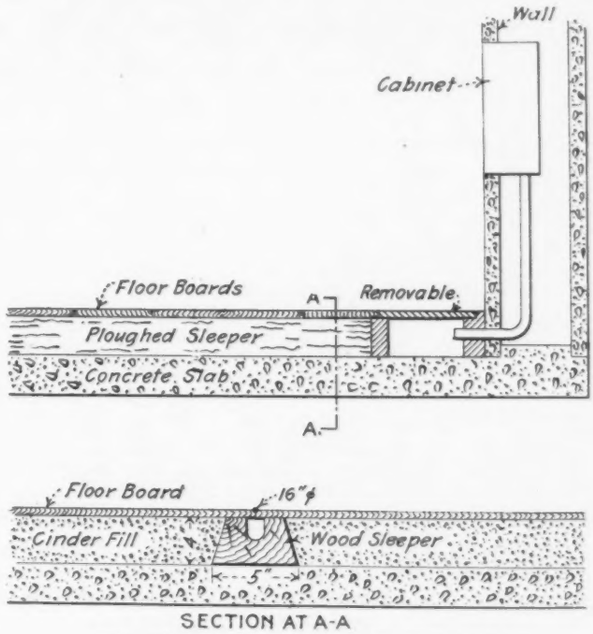


FIG. 13—DETAILS OF FLOOR TRENCHES

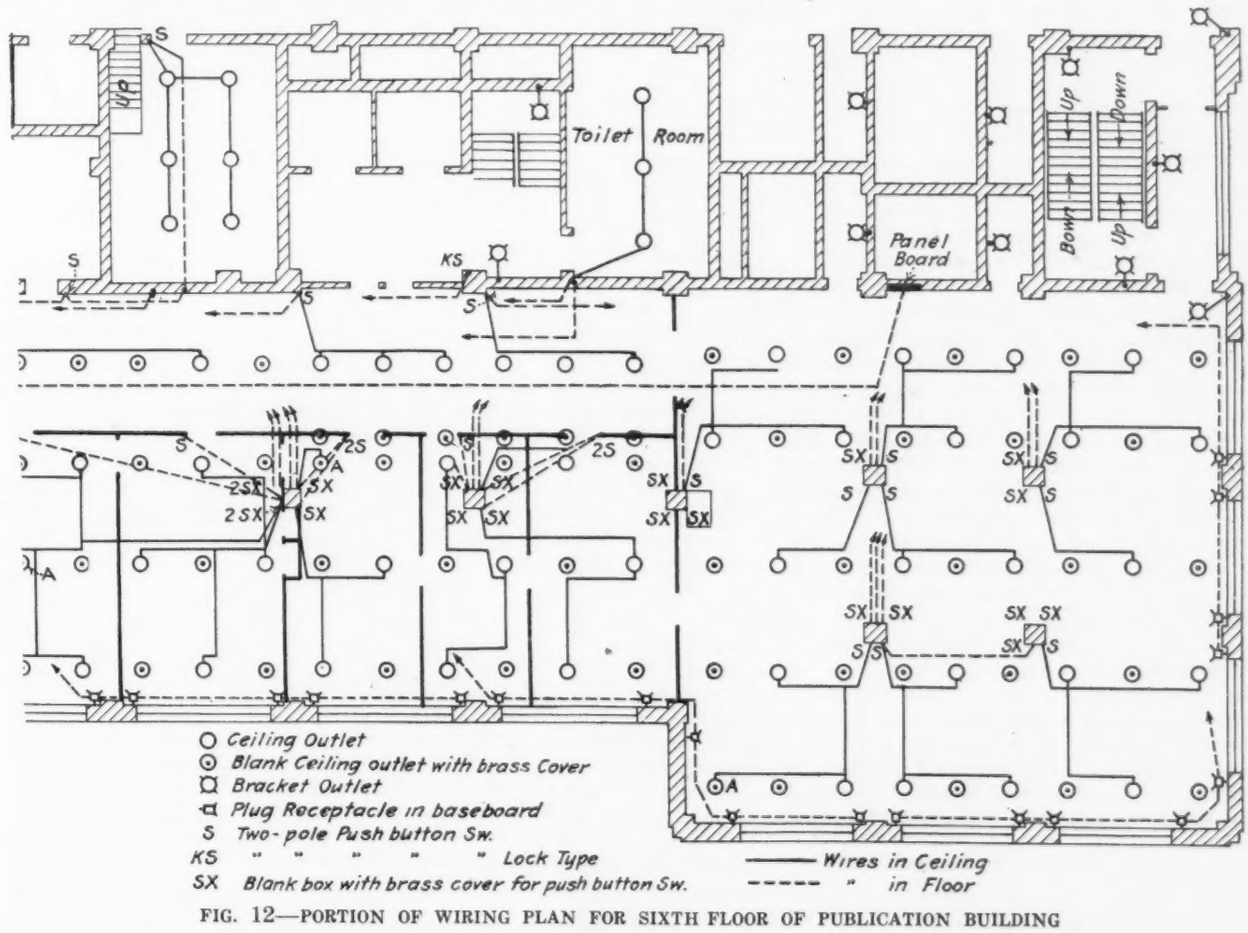


FIG. 12—PORTION OF WIRING PLAN FOR SIXTH FLOOR OF PUBLICATION BUILDING

Effect on the Eye of Ultra-Violet Light

Examination of the Relation That Exists Between Subjection to Abnormal Waves of the Spectrum and Affections of the Lens

BY W. E. BURGE*

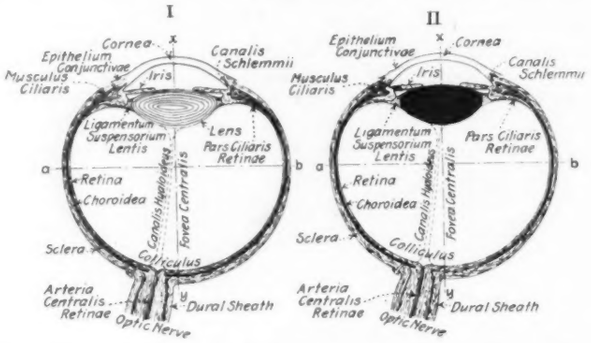
THE term cataract, usually applied to a waterfall, by a transfer of meaning has come to be applied to a disease of the eye in which the crystalline lens becomes opaque and forms an apparent grating over the pupil. In such a condition blindness results because the opaqueness of the lens prevents the light from passing into the interior of the eye.

Fig. 1 represents a longitudinal section of a normal eye. It may be seen that the lens, the most important part of the refractive apparatus of the eye, is a transparent bi-convex body situated between the anterior and posterior chambers of the eye. The anterior chamber is filled with a perfectly clear liquid known as the aqueous humor, whereas the posterior chamber contains a transparent jelly-like material called the vitreous humor. Fig. 2 shows a similar section of the eye, but represents the condition known as cataract. It may be seen that these two photographs differ only in that the crystalline lens in Fig. 1 is transparent while that in Fig. 2 is opaque or cataractous. The sight may be restored by the removal of a lens that has become cataractous. The light then passes unobstructed into the interior of the eye. The rays, however, do not focus properly upon the retina, and vision is not clear. This is remedied by placing a bi-convex glass lens in front of the cornea, but the person possesses no power of accommodation, and vision is perfect only for that distance for which the interposed lens brings the rays of light to a focus on the retina.

It has been observed that in the disorder of nutrition known as diabetes, sugar accumulates in the body fluids. Cataract is of comparatively frequent occurrence in this disease. In 1907 a commission was formed in England to investigate the occurrence of cataract among glassblowers. It was found that cataract was of much more frequent occurrence among workers in this trade than among people generally, so much so that this type of cataract has been included under the employers' liabilities acts of England. By the multiplication of the cells on its surface the lens grows throughout life, hence the more central portions of the lens are the older, harder and less elastic. This arrangement seems to make the lens especially sensitive to disturbances of nutrition. The disturbance of nutrition is thought to account for a type of cataract occurring among elderly people and known as senile cataract. The prevalence of cataract in the tropics has frequently been noted. For instance, Col. Henry Smith has removed in India more than 30,000 cataractous lenses. The question naturally arises, Why is cataract more prevalent in certain types of disease, among workers in certain trades, and in certain localities?

The most plausible explanation for the opacity of the lens, or cataract, is that it is due to the coagulation of the lens protein. Just as egg white and various other proteins may be caused to set and lose their transparency by heating, by adding chemicals, etc., so the lens protein in the case of cataract is precipitated by presence of some abnormal agent. The experiments described in this article were undertaken to find out by what means this precipitation is brought about under the conditions found in the body. The chief function of the crystalline lens is the transmission of radiant energy. The experiments were primarily to determine whether the opacity of the lens, or cataract, could be produced in the performance of this function under extreme conditions.

Effect of Infra-Red and Red.—Sir William Crookes[1] concludes that glassblower's cataract is due to the long waves of the spectrum. This conclusion was based on the fact that he found the radiation from molten glass in the glassblower's furnace to be very rich in red and infra-red. In the present instance experiments were carried out to determine if it were possible to produce an opacity of the lens, or cataract, by the direct exposure of excised pig and ox lenses to the radiation from an electric furnace, which is particularly rich in infra-red. Lenses fitted into floats made of thin rings of cork were almost submerged in open-mouthed glass vessels containing egg-white, blood serum, aqueous and vitreous humor respectively. Each glass vessel was placed in a tank of running water with its mouth slightly above the surface of the water. An electric furnace operating at 1000 deg. C. was inverted and placed directly over the lenses at a distance of 15 cm. The materials



FIGS. 1 AND 2—LONGITUDINAL SECTION OF THE EYE—NORMAL AND CATARACTOUS

were thus exposed, in some cases for as much as 100 hours, without the production of an opacity either in the lenses or in the media. Other experiments were carried out similar to those just described, except that the furnace was placed 5 cm from the surface of the lenses. Under these conditions the lens could be rendered opaque in about ten minutes. On placing the bulb of a thermometer on a lens thus rendered opaque it was found that the temperature in the region of the lens was about 80 deg. C. The conclusion is drawn that the opacity thus produced is due to the rise in temperature, and not to the red and infra-red radiation.

Effect of Visible Spectrum.—Lenses were arranged on floats similar to those described above and almost completely immersed in similar media, viz., egg-white, blood serum, aqueous and vitreous humor. By means of a bi-convex glass lens 4 in. in diameter and with a principal focal distance of approximately 12 in. the filament of a nitrogen-filled tungsten lamp operating at 2000 cp was focused on the lenses. Exposures for as much as 100 hours were made. In no case was opacity of the lens produced.

Similar experiments were made by focusing the image

*Nela Research Laboratory.

[1]Crookes, "Philosophical Transactions," No. A, 509, 1914.

of the sun on the lenses. Opacity in this manner could be produced in a very few minutes, but it was found in every case that the temperature of the crystalline lens was raised sufficiently high to coagulate its protein.

The conclusion is therefore drawn that opacity of the lens, or cataract, cannot be produced by radiation from the region of the visible spectrum and of the infra-red provided that the temperature effect be excluded.

Effect of Ultra-Violet.—Schanz and Stockhausen[2] studied the radiation from the glassblower's furnace and found, contrary to the findings of Crookes, that it was rich in ultra-violet radiation. Hence they concluded that glassblower's cataract is due to the short waves. Experiments were devised to determine if it were possible to produce opacity in the crystalline lens by direct exposure to the ultra-violet radiation from the quartz mercury-vapor arc. Lenses were introduced into quartz tubes previously filled with egg-white, blood serum, aqueous and vitreous humor. The diameter of these quartz tubes was slightly less than the diameter of the lenses, so that each tube was filled in a horizontal direction by means of the lens. The tubes were closed with rubber stoppers and placed horizontally in a tank of running water at a depth of 1 cm beneath the surface of the water and 5 cm below a Cooper Hewitt quartz mercury-vapor burner operating at about 2500 cp. The egg-white and the blood serum became thoroughly coagulated after twenty hours' exposure. The aqueous and vitreous humors were also coagulated after such an exposure. The immersed lenses in all the tubes, however,

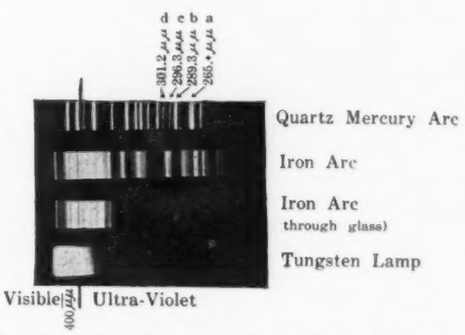


FIG. 3—SPECTOGRAPH PLATE, PHOTOGRAPHED BY M. LUCKIESH

were as transparent after such an exposure as they were at the beginning of the experiment. At the end of 100 hours' exposure there was practically no change in the transparency of the lenses. Other experiments were carried out exposing egg-white, blood serum, aqueous and vitreous humor in the quartz tubes without the immersed lenses. At the end of twenty hours' exposure the egg-white and the blood serum were coagulated, but the transparency of the aqueous and the vitreous humors was not affected by such an exposure. These exposures were continued for 100 hours, and at the end of this period the aqueous humor was as clear as it was at the beginning of the experiment, while the vitreous humor had been rendered very slightly cloudy.

The conclusion is therefore drawn that ultra-violet radiation which is of sufficient strength to render egg-white and blood serum firm coagula in a few hours will not affect the transparency of the crystalline lens or of the aqueous and vitreous humors in 100 hours' exposure. It has been found that ultra-violet radiation will precipitate not only egg-white and blood serum, but practically every other protein[3] and related substance. Thus it would appear that the lens protein and the protein of the aqueous and vitreous humors form a conspicuous exception in that it is impossible to coagulate it by means of ultra-violet radiation.

Effect of Radiant Energy on Lenses of Abnormal Composition.—The above experiments would seem to show that it is practically impossible to produce an opacity of the lens, or cataract, by means of radiant energy from the infra-red, the visible or the ultra-violet regions of the spectrum under conditions much more extreme than any to which the human eye is ever subjected, so there must be some factor involved in the production of cataract other than radiant energy. Some years ago the author[4] made analyses of several thousand cataractous lenses both from the United States and from India, and found that there is a great increase over the normal in the amounts of certain salts. It may be seen from the table below that in the human cataractous lens the percentage of potassium in the ash is greatly reduced while the percentages of calcium, magnesium and sodium are greatly increased over the amounts existing in the normal lens. In cataractous lenses obtained from the United States there was no indication of silicate, while those from India contained distinct amounts of the silicates of potassium, calcium, and possibly of sodium. What conditions caused such a marked deposition of silicate in the cataractous Indian lenses cannot be stated. This increase in calcium, magnesium, sodium and silicon found in the cataractous lenses suggested that their presence might make possible the coagulation of the lens protein by radiant

AVERAGE PERCENTAGE COMPOSITION OBTAINED BY ANALYZING THE COMBINED ASH OF A LARGE NUMBER OF LENSES

	Average Dry Weight of One Lens, Milligrams	Average Weight of Ash of One Lens, Milligrams	Percentage Weight of Ash to Dry Weight	Percentage of K in Ash	Percentage of Ca in Ash	Percentage of Mg in Ash	Percentage of Na in Ash	Percentage of Si in Ash
Normal adult human lens	58.99	1.40	2.30	38.80	?	?	?	0
Normal adult pig's lens	137.70	3.40	2.45	34.30	0.08	1.20	6.67	
Embryo human lens	15.47	0.25	1.60	30.80	?	?	?	0
Cataract human lens (U S A)	34.42	0.58	1.68	9.80	12.50	8.00	23.82	0
Cataract human lens (India)	92.30	1.52	1.64	5.81	6.00	1.60	25.06	3.63

energy, even though under normal conditions radiant energy has no effect on the protein. To test this hypothesis, experiments were performed using the same apparatus as before but with [5]*m*/100 calcium chloride, *m*/100 magnesium chloride and *m*/100 sodium silicate as media for the lenses. Since cataract has been found as a complication of diabetes, *m*/100 dextrose was also used as a medium. These solutions of themselves did not affect the transparency of the lenses after more than 100 hours of immersion.

Effect of Infra-Red and Visible Spectrum on Lenses in Salt Solutions.—Lenses were immersed for two hours in *m*/100 calcium chloride, *m*/100 magnesium chloride, *m*/100 sodium silicate, and *m*/100 dextrose, respectively. They were then exposed to the radiation from the electric furnace, the tungsten nitrogen-filled lamp and the sun. Exposures were made as in the preceding experiments without affecting the transparency of the lenses or of the media, provided that the effect due to rise in temperature was excluded.

Effect of Ultra-Violet on Lenses in Salt Solutions.—

[2]Schanz and Stockhausen, von Greafe, *Archiv. f. Ophth.*, Vol. lxxiii, p. 553, 1910.

[3]Dryer and Hanssen, *Comptes Rendus*, Vol. cxlv, p. 234, 1907.

[4]Burge, *Archives of Ophthalmology*, Vol. xxxviii, No. 5, p. 447, 1909.

[5]A gram-molecular or "m" solution contains per liter of solution the number of grams of the salt equal to its molecular weight. *m*/100 is a solution of 1/100 the concentration of a gram—molecular solution.

Similarly, quartz tubes containing similar media and immersed lenses were prepared and after two hours were exposed to the radiation from the quartz mercury-vapor lamp. It was found that the solution in the quartz tube containing a lens immersed in $m/100$ calcium chloride became turbid after twenty-five minutes' exposure. The portion of the lens on the side next to the burner had become an opaque mass after seventy-two hours, whereas the transparency of the half of the lens away from the burner was only slightly affected. The same thing happened on the exposure of a lens immersed in $m/100$ magnesium chloride, in $m/100$ sodium silicate or $m/100$ dextrose, except that the effect was not so marked and was not produced so quickly as when calcium chloride was used.

The conclusion is therefore drawn that the lens protein, which normally cannot be precipitated by ultra-violet radiation, can be so modified by those substances which have been found to be greatly increased in cataractous lenses that ultra-violet radiation can precipitate it and hence produce an opacity of the lens; this conclusion referring specifically to calcium, magnesium, sodium and silicon,[6] and to dextrose, which is found in increased amounts in the liquids of the body in the disease known as diabetes.

Further Analysis of the Effect of Ultra-Violet.—Experiments were carried out, using the Fuess quartz spectograph in order to determine which wave-lengths emitted by the quartz mercury-vapor arc caused the precipitation of the modified lens protein.

Clear fresh egg-white was introduced into a quartz cell. The cell was made of two quartz disks 4 cm in diameter and 1.2 mm thick. These disks were separated by a ring of hard rubber 0.8 mm thick with an inside diameter of 3.8 cm. By means of the spectograph the spectrum from an 800-cp quartz mercury-vapor lamp was focused on the egg-white. The slit of the spectograph was 1 mm wide and the burner was placed 3 cm from the slit. The coagulation of the egg-white began after fifteen hours toward the extreme end of the ultra-violet in the form of a well-defined band of white coagulum corresponding in position to that of an intense band of the spectrum marked *a* in the illustration Fig. 3. Although *a* appears as one intense band, it is in reality composed of three fused bands, of wave-lengths 265.2μμ, 265.3μμ and 265.5μμ respectively. At the end of twenty-four hours three more bands of coagulated egg-white were to be seen, corresponding in position to three other bands in the spectrum, viz., *b*, *c* and *d*, having the wave-lengths 289.3μμ, 296.3μμ and 302.1μμ respectively. From these results it would appear that the effective region in producing coagulation of the egg-white is from 265μμ to 302μμ inclusive, and that the most effective region is around 265μμ for the quartz mercury-vapor arc.

Five lenses were placed in a 0.25 per cent solution of calcium chloride for two hours, and at the end of this time the clear liquid was poured off and introduced into the quartz cell described above, and exposed in the same manner as the egg-white had been. At the end of fifteen hours there could be seen one delicate white band of coagulated lens protein in the ultra-violet region where the egg white had been first coagulated, namely, in the region marked *a* in the illustration. At the end of twenty-four hours' exposure two more delicate white bands appeared, more or less well defined, of coagulated lens protein. These two bands corresponded in position to the same two bands in the region of the ultra-violet where the egg-white had coagulated after twenty-four hours, marked *b* and *c* in the illustration. In place of the other band where the egg-white was precipitated, marked *d*, there was an ill-defined hazy precipitation of modified lens protein.

The same conclusion can be drawn regarding the precipitation of lens protein as was drawn regarding egg-white, viz., that the effective region is from 265μμ to 302μμ inclusive, and that the most effective region lies around 265μμ for the quartz mercury-vapor arc.

Conclusion.—On the basis of the experiments cited in this paper the assumption may be made that in looking for the causes of cataract at least two factors should be considered, the one a modification of the protein of the lens and the other radiation of short wave-lengths, by which this modified protein can be precipitated. According to this hypothesis, the prevalence of cataract among diabetics could be accounted for by the increased amount of sugar in the body fluids, this increased sugar modifying the lens protein to such an extent that the small amount of ultra-violet radiation in ordinary sources of illumination, such as the sun, or practically any artificial illuminant, can bring about the precipitation of the lens protein. In this case the "modification" factor, the sugar, is large, whereas the radiant energy factor is small. The glassblowers who develop cataract form a relatively small percentage of those engaged in that occupation, although the quality and quantity of radiation from the furnaces to which their lenses are exposed is relatively rich in short wave-lengths. It may be assumed that the small percentage who do develop cataract have a more or less disturbed condition of nutrition, expressing itself in an increase of sugar, calcium, magnesium or some other substance, which can so modify the lens protein that the short wave-lengths of the spectrum are able to precipitate it. Assuming that nutritional disturbances are as frequent among the workers in other occupations as among glassblowers, the prevalence of cataract among glassblowers would seem to be explained by the excess of the radiant energy factor acting upon slightly modified protein. The prevalence of cataract in India is accounted for by the increase in the radiant energy factor and of substances that can modify the lens protein. It is known that tropical light is comparatively rich in ultra-violet radiation, and analyses of Indian cataractous lenses show them to contain silicon, which, as has been shown above, can so modify the lens protein that ultra-violet radiation can produce opacity of the lens, or cataract.

[6] As sodium and silicon were only used together in these experiments in the form of sodium silicate, it is impossible to say whether one or the other or both the constituents jointly is effective in the production of cataract.

Electricity for Drying Films

Until recently one of the greatest delays in converting exposed films into finished pictures was caused by inadequate facilities for drying the negatives. At the Standard Film Company, Yonkers, N. Y., the films, as soon as they are developed, fixed and washed, are wound on huge drums which are rotated rapidly in electrically heated air. Each drum, which is about 27 ft. in circumference, is driven by a 1-hp motor so that the air in contact with the wet emulsion is constantly changed. One 3000-watt air heater is set back of each drum. Before the heaters were employed it usually required from seven to ten hours to dry a reel of film, and never less than four hours, depending on the humidity of the atmosphere. Now films can be dried in about one-quarter of the time formerly required. Another advantage which has been obtained from rapid drying is that the films, by not being allowed to become soggy with moisture, are turned out tough and durable. Energy is furnished for this installation by the Yonkers Electric Light & Power Company.

NATIONAL ELECTRICAL SAFETY RULES

A Description of the Code for Stations, Lines, Utilization Equipment and Operation

BY EDWARD B. ROSA, CHIEF PHYSICIST OF THE BUREAU OF STANDARDS

In the article published in the ELECTRICAL WORLD of April 3, 1915, page 845, an account was given of the steps which have led to the development of the new National Electrical Safety Code to date and what is planned for the future; and the cordial and valuable co-operation which the Bureau of Standards is receiving in this work was described. The present article deals with the rules themselves and with the present plans for introduction thereof.

The proposed code, in the preparation of which the bureau has been engaged for more than a year, and which is about to be issued in a preliminary edition for discussion and criticism, is intended to run parallel to the electrical code (for fire protection) prepared and revised from time to time by the electrical committee of the National Fire Protection Association. Together they will constitute a truly complete national electrical code. The compensation laws of many states and the responsibilities imposed upon many state commissions established recently make it necessary that electrical safety rules be put into effect somewhat generally and at an early date. Several state commissions began the preparation of such rules some time ago, and the Bureau of Standards undertook to co-operate with some of them in so doing. But when the plans of the bureau for preparing an electrical safety code that could be adopted generally became known, these commissions signified their desire to co-operate in this work and to adopt the national code if possible without change, or in any event with as few exceptions as possible, so as to give the maximum degree of uniformity of practice among the various states.

The Workmen's Compensation Service Bureau, which makes inspections of industrial properties for a large number of casualty companies, also began the separate preparation of an electrical safety code, but it too gave up the undertaking when it became acquainted with the work of the Bureau of Standards. Since that time the bureau has had the co-operation and assistance of the Workmen's Compensation Service Bureau, which is planning to use the National Electrical Safety Code as the basis of its inspections. This will have a considerable influence in bringing the new code rapidly into general use.

Arrangement of the Code

As already indicated, the proposed code consists of four principal parts, these being preceded by a group of definitions and followed by two appendixes. The numbering of the sections and of the rules is on the decimal system. The definitions bear numbers below 100. The rules on stations are divided into nine sections, and ten numbers are reserved for each section, although there are less than ten rules in most sections. Thus Rule No. 111 is in Part 1, Section 11, and is the second rule of that section, the first being No. 110. The rules on lines are numbered from 200 up, the rules on utilization equipment are numbered from 300 up, and the rules on operation are from 400 up. The accompanying tables give a list of the sections of the four parts of the code.

By this arrangement additional rules may be added to any section in successive revisions without disturbing the numbers of the present rules. The rules in Part 2 are on the average longer than the others; altogether they occupy about the same space as those of Parts 1 and 3. On the other hand, the rules of Part 4 are somewhat shorter on the average than the others. The whole code of 292 rules will occupy less than one-half the space required for the present Underwriters' Code.

For convenience of the different administrative authorities who have to deal with them separately, each of the four parts is as nearly complete in itself as possible.

SECTIONS OF THE FOUR PARTS OF THE PROPOSED NATIONAL ELECTRICAL SAFETY CODE

PART 1. STATIONS AND SUBSTATIONS (SIXTY-FIVE RULES)

Nos. of Sections		Nos. of Rules
10	Protective Arrangements of Stations	100-105
11	Protective Arrangement of Equipment	110-117
12	Rotating Equipment	120-125
13	Storage Batteries	130-136
14	Transformers, Reactances, Induction Regulators, Balance Coils, etc.	140-144
15	Conductors	150-156
16	Switches, Fuses, Controllers, etc.	160-168
17	Switchboards	170-179
18	Lightning Arresters	180-186

PART 2. ELECTRICAL SUPPLY AND SIGNAL LINES (FORTY-NINE RULES)

20	General Requirements	200-207
	Overhead Lines	
21	Construction Required for Crossings, Conflicting Lines, and Lines on the Same Supports	210-213
22	Clearances of Conductors at Crossings	220-223
23	Clearances of Conductors (Other than Crossing Clearances)	230-235
24	Guarding Live and Arcing Parts	240-243
25	Supporting Structures	250-256
26	Conductors and Insulators	260-262
	Underground Lines	
27	Manholes, Handholes and Ducts	270-277
28	Conductors and Equipment	280-284

PART 3. UTILIZATION EQUIPMENT (SIXTY-TWO RULES)

30	Protective Arrangements (General Rules)	300-307
31	Conductors	310-317
32	Switches, Fuses, Controllers, etc.	320-327
33	Switchboards	330-337
34	Motors and Motor-Driven Devices	340-345
35	Arc Welders and Electrical Furnaces	350-352
36	Lighting Fixtures and Signs	360-368
37	Portable Devices, Cables and Connectors	370-374
38	Electrically Operated Cars, Cranes and Elevators	380-383
39	Telephones and Other Signal Apparatus	390-392

PART 4. OPERATION OF ELECTRICAL EQUIPMENT (116 RULES)

	Rules for Employers	
40	Organization	400-407
41	Protective Methods and Devices	410-417
	General Rules for Employees	
42	General Precautions	420-428
43	General Operation	430-437
44	Handling Live Equipment and Lines	440-449
45	Killing Supply Equipment and Lines	450-459
46	Killing Moving Parts	460-466
47	Making Protective Grounds	470-474
	Special Rules for Employees	
48	Supply Station and Switchboard Operation	480-487
49	Overhead-Line Operation	490-496
50	Underground Operation	500-506
51	Series Arc Lamp Operation	510-513
52	Meter Operation	520-524
53	Testing Operations	530-535
54	Signal Line Operation	540-545
55	Tunnel and Subway Operation	550-557

Appendix A—Grounding Circuits, Equipment and Lightning Arresters.

Appendix B—Sag Tables for Hard-Drawn Copper and Aluminum Conductors.

Distinction Between Station and Utilization Equipment

In an introductory paragraph to the rules for stations it is stated that the rules apply to the electrical supply equipments of indoor and outdoor stations and substations, and also to similar equipment, including

generators, motors, storage batteries, transformers and lightning arresters when in factories, mercantile establishments or elsewhere, provided they are in separate rooms or inclosures, under the control of properly qualified persons, when such rooms or inclosures are inaccessible to others. Thus, the room or rooms in which the transformers, high-tension switches and distributing switchboard are installed in a factory are regarded as a substation, if under the charge of a qualified person, and subject to the rules for stations. On the other hand, the electrical wiring, motors, switches and other equipment distributed about a factory or other building where employees generally have more or less access to them are regarded as utilization equipment.

The rules for utilization equipment have been prepared for circuits and apparatus at not over 750 volts. Anything inclosed in rooms not accessible to employees generally will come under the rules for stations. Anything of higher voltage than 750 not so inclosed, and remaining accessible to others than properly qualified electrical operators, must, in addition to complying with the rules for stations and such of the utilization rules as apply, have all live parts incased in permanently grounded metal conduit or cases or otherwise guarded to prevent access or unsafe approach by any person to the live parts.

Overhead Lines

The most difficult section of the rules to prepare has been that on overhead lines. One might suppose that the large number of reports that have been published by engineering societies and others on this subject and the various specifications and agreements in existence would furnish so much material that the task would be easy. But there is so much difference of opinion and of practice, and so much of this printed material has been proved not to be suitable for use in these safety rules, that it was necessary to study the subject thoroughly and start afresh on many points. The rules for crossings of energy-transmission and signal lines over railways and other transmission lines, for conflicting lines, for clearances between conductors on the same lines, for climbing space, attachments to poles, etc., have been studied and discussed in conferences very thoroughly, and while they are not as yet in all respects satisfactory, they have met general approval from many very competent engineers who have examined them.

No restriction is placed on the voltages that may be carried on overhead wires, either in the country or in cities, but a higher grade of construction and greater precautions are specified for high voltage wires. Probably the greater number of accidents from 2300 volts on the streets is partly due to the fact that the line construction concerned is inferior to that usually provided for 6600 volts or 13,000 volts.

The danger from fallen wires due to breaking of the wires or failure of the poles makes it very necessary to require something definite respecting the strength of construction of overhead lines in cities and congested communities, apart from the requirements made for crossings and conflicting lines. But the requirements are not so high as for crossings over railroads or for crossings or conflicts with signal lines. Hence two grades of construction are specified, these being designated as A and B, and they differ only with respect to the factors of safety specified for the supporting structures. For steel structures and reinforced-concrete poles and cross-arms the factors of safety are three and two for grades A and B respectively; for wood poles they are four and two respectively.

Those who are familiar with crossing specifications that specify a factor of safety of six for wood poles may regard four for the highest grade of construction as too low. But careful consideration of the question seems to indicate that six is an excessive factor of safety even for new poles, when reckoned on the basis adopted, which is the same as that usually taken, namely, assuming all wires loaded with ice to a radial thickness of 0.5 in. and a wind pressure of 8 lb. per sq. ft. on the sectional area of the wires and on the poles. This corresponds to a wind velocity of about 60 miles per hour. When a high factor of safety is assumed it is generally in part to provide for extreme conditions, but in this case, because of their known though rare occurrence, fairly extreme conditions are assumed as the basis of calculations of the wind pressure, and a factor of safety of four requires considerable guying of poles when as many as twelve No. 2 wires are carried on a 40-ft. pole line.

It is provided that wood poles and cross-arms shall be replaced when their factors of safety have decreased to one-half that required when new. This is not a severe requirement where poles are guyed, as the support of the guys is included in the calculation of strength. But in cities it happens frequently that guys cannot be used, and in such cases this requirement makes it necessary to keep careful account of the depreciation of the poles. There is much need of experimental work to determine more accurately the extent to which guyed poles support unguyed poles one or more span lengths away and other quantities that enter into the calculation of factors of safety of overhead lines. It is hoped that before the rules are revised in 1916 much additional information will be available that will be useful in line construction as well as in making the requirements more precise and treatment more adequate in this section of the safety rules.

Sag tables are given for hard-drawn copper, and aluminum wire and minimum sags are specified, so that a factor of safety of two will be obtained for the conductors under the extreme conditions specified. It is specified that the sags in the case of soft-drawn copper be at least double those for hard-drawn copper, the ultimate strength of soft-drawn wire being only one-half that of hard-drawn wire. Under this rule soft-copper conductors under heavy loading of ice and wind will stretch and the sag will increase. This serves as a safety measure to prevent breaking, but makes it necessary to tighten up the wires frequently after severe storms to keep the clearances normal, and to prevent blowing together. Most companies prefer to do this rather than use hard copper for distribution lines.

One important difference from some specifications previously proposed is that in the present rules clearances are specified for normal temperatures and without ice loading or wind, so that the company or inspector can tell by examining the crossing or line under normal conditions whether it meets the rule. Some of the previous specifications have provided that the clearance should be a certain amount under the most severe conditions of wind and of ice-loading. This made it practically impossible, when the line was inspected under normal conditions, to tell whether the requirement had been complied with or not, since the exact conditions are not stated and so many varying factors enter into the problem.

It is not possible even to mention all the interesting features of the rules for overhead lines. In general they have been so drawn as to specify the results to be attained and often the method, leaving as much as possible of the details to the discretion of the companies.

Existing Installations

The rules of Parts 1, 2 and 3 apply, of course, to all new installations, unless modified for special reasons by

the proper administrative authority. The question as to what extent they should apply to existing installations has been considered carefully. Obviously, if they did not apply at all to existing installations, they would have comparatively little useful influence for many years to come.

The statement made in the introduction to the rules in regard to this question is as follows:

"The rules apply to existing installations: (*a*) in extensions and reconstruction, except where for special reasons this is impracticable; (*b*) in cases of serious danger that can be obviated by conforming to the rules; (*c*) in the placing of guards and grounding of parts for the protection of employees and others where the expense is not substantially greater than would be required for providing such protection for new equipment."

The time allowed for compliance with (*b*) and (*c*) will, of course, be fixed by state or municipal administrative authorities.

It is not expected that expensive changes will be made in existing equipment in order to comply with the rules except in so far as it is necessary to do so in order to remove a source of serious danger. But in most cases grounding of machine frames, instrument cases or conduits, or erecting of suitable guards (where exposed live parts require it), can be done at substantially the same expense as though it were new equipment, and in all such cases it is expected that it will be done within some reasonable time.

Enforcement of the Rules

There is so much interest in the subject of safety and so many managers are anxious to have their employees protected properly that it is believed that in a large percentage of cases the rules will enforce themselves. If the state commissions and municipal administrative officers provide intelligent and thoroughly competent inspectors, so that to some extent their inspections will have an educational value, the administration of the rules ought to be relatively simple. When force has to be applied in some particular case it may be done far more easily if the administration of the rules is intelligent and reasonable and compliance is generally a willing one. It is hoped that such intelligent and competent inspection may be secured, and the Bureau of Standards will do all that it can to assist commissions and municipalities to give this kind of inspection.

Another important question in the administration of the rules is that of uniform interpretation by the persons who are expected to comply with the rules and by the inspectors and others who administer them. In the preliminary edition of the rules a series of explanatory notes has been included, the notes occupying about as much space as the rules. The purpose of the notes is to assist in understanding the rules and their application. It has been suggested to the bureau that a textbook on safe construction and operation is needed much more than a set of rules. It is hoped that the notes to the rules as they will be expanded in the later publication will fulfil to some extent, in connection with the rules, the function of such a textbook. We shall be greatly pleased to receive suggestions as to what additional material should be put into the notes.

Many of the rules are put in the mandatory form by the use of "shall"; others are intended as strong recommendations, "should" being used to indicate that fact. "Should" is often used where it would be proper to require a certain thing of some companies but not of all. In some cases "it is recommended that" are the words used. It was thought far better to make the rules reasonably near complete, with some of them not mandatory, than to cut out all that could not properly be made generally mandatory. If the attempt had been made to make everything absolutely required, there would necessarily have resulted either a very incomplete safety code, or one that could not be enforced, or one that would work a hardship in very many cases. It seems far better, particularly in the early history of such a code, to regard it as an educational and helpful influence quite as much as a code to be enforced.

Introduction of the Code

It is the hope of the Bureau of Standards that when the code has been revised once more and approved by the Washington conference and republished, it may be adopted very generally and with the minimum changes by individual states and cities. It is suggested, however, that the first year may be made a trial year, during which the companies, inspectors and commissions may become thoroughly acquainted with its practical operation, and that it be not enforced in any strict sense until after the first year. We believe that if the utilities and other companies coming under it are invited to "try out" the code, to comply as well as they can, to report wherein it is not satisfactory, and to assist in the effort to remedy its defects by revision at the end of the first year, far better results will be attained in the end than if it were made compulsory at the start. Some commissions and municipalities might delay adopting it formally if a strict enforcement were expected from the beginning, whereas they might be entirely willing to adopt it at once in the experimental way suggested. It is believed that this plan will secure the full co-operation which is much to be desired.

A copy of the preliminary edition of the first three parts of the code will be sent on request to anyone wishing to receive it, as well as a copy of the revised operating rules, which will shortly be issued as the second edition of Circular No. 49. When the first three parts are republished after approval by the Washington conference, the operating rules will be added and the whole will constitute the complete National Electrical Safety Code.

Telegraph Company Reports to Authorities

In his report for the year 1914, Mr. Newcomb Carlton, president of the Western Union Telegraph Company, says that the company is subject to forty-three public service commissions and twenty-three workmen's compensation or industrial commissions. Besides voluminous reports to these commissions, the company has also to prepare 3100 annual reports to tax authorities, these reports being further subdivided by taxing districts. In all, there are required not less than 17,700 statements to public authorities. In addition, the company has now to collect and remit monthly to the government the internal-revenue tax levied recently upon commercial telegraph messages.

The company conducts a large national and international telegraph and cable business, the operating revenues being derived not only from various classes of message services but also from commercial news, stock quotations, money-order transfers, etc., in addition to which there are operating contracts with 260 railroad systems, which include many subsidiary intrastate and interstate railroad lines. For these reasons a satisfactory separation of revenues and expenses between interstate and intrastate business is impracticable. It would seem, therefore, to be in the public interest, Mr. Carlton adds, that such a company should be relieved of rate regulation and the supervision of accounting statements by states and should report in these respects to the federal commission alone.

DIGEST OF ELECTRICAL LITERATURE

Generators, Motors and Transformers

Sinusoidal Voltage Curves from Polyphase Alternators.—W. SEEMANN.—The author discusses the way in which higher harmonics are produced in the wave-forms of the voltage curves of polyphase alternators and describes four methods of different manufacturers by which a more or less purely sinusoidal wave-form may be obtained. He finally describes a new method of his own which is illustrated in Fig. 1. All the slots in the rotor are made of equal size, but the wedges are larger

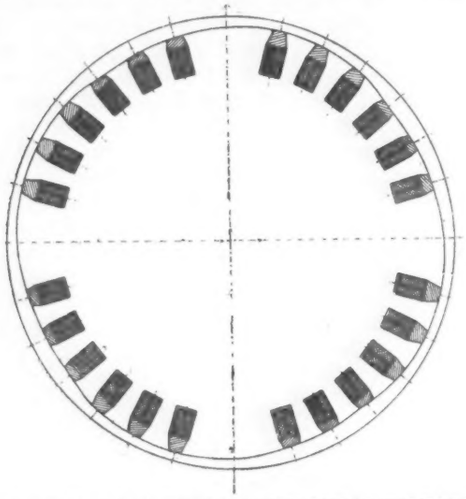


FIG. 1—METHOD OF OBTAINING SINUSOIDAL VOLTAGE CURVE

than usual in ordinary practice. The rotor is constructed symmetrically, and when the machine is finished a test is made by which the field curve or the voltage curve is obtained. The field curve will be found to be somewhat distorted and on paper the equivalent sinusoidal curve is plotted. For each point there is thereby obtained the difference between the value of the induction flux density as it is and the value as it should be for the sinusoidal curve. The rotor is now turned off mechanically in such a way as to obtain at each point the currect flux density. The change of the flux density is obtained by a change of reluctance and the change of reluctance by a change of the air gap at the different points around the circumference of the rotor. This is illustrated in Fig. 1, the rotor circuit being no longer the exact circle.—*Elek. Zeit.*, March 4, 1915.

Generation, Transmission and Distribution

Electric Supply in Scandinavia.—A note stating that statistics from almost every large town testify to the continuous growth of the use of electricity, and most cities are constantly planning and carrying out large extensions. In addition to a large transformer station, in which the three transformers are of the La Cour cascade type, the fourth being an older type, the Copenhagen municipality has prepared plans for a new electric central station, calculated to cost some $3,250,000. It will be situated close to the Kallebod waterway, just outside the town. The first Copenhagen municipal electric station entailed an expenditure of $625,000, and now the municipal electric stations represent an aggregate outlay of some $6,400,000, the equipment rating having, since the commencement, increased from 1150 kw to 25,000 kw. Large extensions have been made gradually to the Stockholm municipal electric supply, and the completion of the large Untra hydroelectric station will give increased impetus to their growth. In the meantime the war has not effected a reduction in the consumption of electrical energy in the Swedish capital, although the consumption for lighting somewhat receded in the first few months after the commencement of war, the works themselves urging economy for fear lest the supply of coal might present some difficulties. The consumption of three-phase energy for the larger industries even shows a very great increase. During the first seven months of 1914 the Stockholm municipal electric central station supplied 4,370,200 kw-hr., against 1,375,720 kw-hr. for the same period of 1913; during the months between August and November, 1914, the consumption was 2,913,500 kw-hr., against 2,173,800 kw-hr. for the same period of the preceding year, an increase of, respectively, 218 and 34 per cent, or 105 per cent on the first eleven months of last year. All over the country new hydroelectric stations are being constructed, and arrangements are made in some cases between large electric stations whereby the supply of energy can be further insured and consolidated. Thus the Gullopang-Munkfors Electric Power Company is arranging with the large State hydroelectric station at Trollhättan for the supply of 3300 kw for a series of years for the benefit of the town of Orebro. A high-voltage line from Trollhättan to a large transformer station at Lidköping, to be ready in the course of the ensuing summer, should enable electric stations to supply energy to several industrial concerns in the neighborhood, so that they need not themselves provide any reserve equipment for possible dearth of water.—London *Engineering*, March 12, 1915.

Transformer Station.—The Luossavaara Kirunavaara company has arranged with the Swedish State for the supply of about 8000 electrical hp for use in the company's iron mines. Energy is transmitted by means of three-phase currents at a frequency of twenty-five cycles at 72,000 volts. The transforming station is described and illustrated. Use is made of 2000-kva, single-phase transformers suitable for operation at 80,000 volts. They are star-connected, so that the primary emf is 41,000 volts, and the ratio of transformation is such as to give a secondary voltage of 1270. The plant is protected by electrolytic lightning arresters.—London *Engineering*, March 12, 1915.

Traction

Prevention of Interference of Alternating-Current Railways with Telephone Lines.—A note on a recent British patent (No. 3831, 1914) of the British Thomson-Houston Company and the General Electric Company of this country for a method of avoiding interference of single-phase railways with neighboring telephone circuits, etc., by connecting the trolley lines and return circuit by series transformers, consisting of a connection between the rails and center of such transformers and reactive connections between the rails and points on the return conductor between the transformers. This is to direct the current into the return conductor so that its inductive effect more completely neutralizes that of the trolley line at every point.—*London Elec. Eng'ing*, March 18, 1915.

Installations, Systems and Appliances

Siam.—An article on the electrical trade of Siam. The capital of Siam, Bangkok, has two electric central stations. The station of the Siam Electricity Company, which is a private corporation, formerly supplied single-phase energy at 100 cycles, 2000 volts, transformed down to 100 volts, but was recently changed to

three-phase, fifty cycles, and a station pressure of 3500 volts was adopted. Two 1000-kw turbo-alternators supply the three-phase energy, while the tramway energy is obtained from a motor-generator and alternately from a steam-engine-driven direct-current machine. The second station is the government-owned power plant, which contains three turbo-alternators rated at 1335 kva, 3500 volts, fifty cycles, and a motor-generator of 375 kw, together with a storage battery. The station pressure is 3500 volts to 3850 volts, the distribution lines being kept at 3500 volts. There are 120 km (72 miles) of high-tension distribution lines in operation. Some data are given on language, weights and measures, coinage, climate, fauna and the different industries of Siam, as well as on the railway system. In conclusion, notes are given on the chief electrical goods the sale of which would be useful in Siam.—London *Elec. Review*, Feb. 19, 1915.

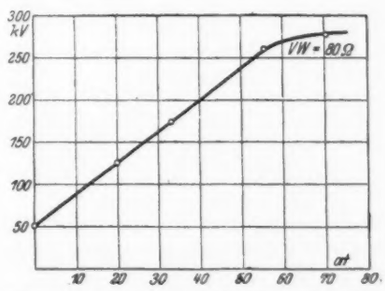
Alternating-Current Reverse Relays.—C. C. GARRARD.—The conclusion of his article illustrated by diagrams. The author describes and illustrates the connections of alternating-current reverse-power relays if the neutral point is earthed or not earthed. He finally discusses leakage protection by methods in which the leakage of a current from the circuit automatically operates relays so as to disconnect the faulty circuit from the system.—London *Electrician*, March 12, 1915.

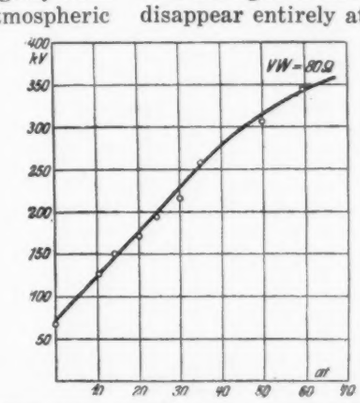
Wires, Wiring and Conduits

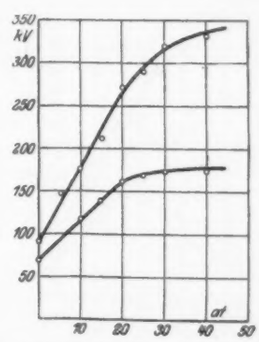
Electric Perforation Strength of Liquids, Semi-Liquids and Solid Insulation as Affected by Pressure.—F. KOCK.—The conclusion of his illustrated article on the effect of atmospheric pressure on the electric perforation strength (in kilovolts per centimeter) of liquid, semi-liquid and solid dielectrics. In the present instalment the author gives the results for the following liquids: transformer oils, castor oil, paraffine oil, petroleum, benzol and toluol. The semi-liquids, yellow vaseline and paraffine were investigated. Hard rubber was the only solid dielectric tested. For hard rubber the perforation strength, while increasing very slightly with the pressure, is practically constant from atmospheric pressure to an excess pressure of 70 atmospheres. On the other hand, the curves for the perforation strength of liquid and semi-liquid insulators as functions of the atmospheric pressure are first straight lines, but they bend and become asymptotic to the ordinate of abscissas. This means that in the lower ranges of pressure the perforation strength increases proportionally to the pressure but at higher pressures it increases less quickly. Figs. 2 and 3 show the perforation voltage in kilovolts as a function of the excess pressure in atmospheres for paraffine oil. Fig. 2 refers to paraffine oil which has not been boiled and filtered, Fig. 3 to paraffine oil which has been boiled and filtered. The two curves demonstrate clearly the difference in the perforation strength due to the content of moisture and to dust particles in the oil. The content of water in the oil was so small that it could not be found by the ordinary methods. The effect of the frequency and the wave-form was also tested. The pressure was varied between twenty and sixty cycles per second, and it was found that the perforation strength of the oil decreases with decreasing frequency. This seems to indicate that the phenomena with break-down of a liquid insulator occurs with a certain inertia. Fig. 4 shows the results obtained with a transformer oil. The upper curve refers to a test with sinusoidal alternating current of fifty cycles with series resistance and the lower refers to a direct-current test with an influence machine. The difference of the two curves shows that the perforation strength is smaller for direct current and increases much more slowly with increasing pressure. Experiments were made to determine the effect, if any, of pressure on the insulation resistance, but the results were negative. The conductivity of the insulators is independent of the pressure, the following being the values in c. g. s. units: Castor oil, 1.18×10^{-13}; transformer oil, 4.96×210^{-14}; petroleum, 1.81×10^{-15}; toluol, 7.8×10^{-15}; benzol, 1.11×10^{-19}; vaseline, 2.12×10^{-16}. An explanation of the variation of perforation voltage with atmospheric pressure is attempted in the conclusion of the article—*Elek. Zeit.*, March 4, 1915.

Electrophysics and Magnetism

Light Produced by Recombination of Ions.—C. D. CHILD.—An abstract of an American Physical Society paper. Certain phenomena connected with the luminosity of the light rising from the mercury arc indicate that this light is produced by the recombination of ions. If this explanation is correct, the light must continue for a time after the current through the arc has been stopped. This can be tested by observing the light from an alternating-current arc at different phases of the current. Such observations have already been made for the carbon arc in air by Fleming and Petavel, who found that the light from the gas between the carbons does not disappear entirely at the time when the current is zero. Since the phenomena with carbon arc in air are complicated by the oxidation of the carbon and by the high temperature of the gas, it seemed desirable to repeat their experiment, substituting mercury terminals in a vacuum for carbon terminals in the air. This has been done, and it has been found that in this case also the light continues to exist for an appreciable length of time after the current has ceased flowing. Such light cannot be due to ionization and is in all probability due to recombination of the ions. Measurements are now being made for the purpose of learning the length of time that the light continues after the current ceases and the rate at which the light dies away.—*Physical Review*, February, 1915.







FIGS. 2, 3 AND 4—CURVES SHOWING PERFORATION VOLTAGE AS A FUNCTION OF ATMOSPHERIC PRESSURE

Electrochemistry and Batteries

Primary Battery.—E. Bellini.—An illustrated description of a new primary battery. The negative electrode is formed of an amalgam of lead, formed by pouring mercury into molten lead. A suitable proportion is to take one part by weight of mercury and nine parts by weight of lead. The positive electrode is carbon. The electrolyte is a mixture of sulphuric and nitric acids. A suitable proportion for the mixture is found by mixing a liter of water with 80 cu. cm of sulphuric acid of 66 deg. Baumé and 120 cu. cm of nitric acid of 36 deg. Baumé. The emf of this battery is 1.25 volts. Typical discharge curves are given, as well as a curve of the internal resistance of a function of the current. —From *La Lumière Elec.*, Nov. 30, 1914, translated in abstract in London *Electrician*, March 19, 1915.

Units, Measurements and Instruments

Determination of Radium.—Walther Bothe.—The content of radium in slightly radioactive substances such as ore, ore residues, etc., has been determined in the past almost exclusively by the emanation method. But this requires considerable time and experimental skill. The gamma-ray method would be far more convenient if it could be made sensitive enough. It is true it has the disadvantage that any mesothorium which may be in the ore is measured together with the radium, while the emanation method gives directly the contents of radium alone; but in most cases it is possible to conclude from the origin of the ore whether it contains an appreciable quantity of mesothorium or not. The author describes an electroscope by means of which it is relatively easy to determine the radium contents of slightly radioactive mesothorium-free substances in a short time, with an accuracy sufficient for practice, by measuring the gamma radiation emitted from a weighed quantity of the substance.—*Phys. Zeit.*, Feb. 1, 1915.

Induction Meters.—W. H. Pratt.—In designing an instrument for measuring alternating-current energy, there are a number of variable factors that must be taken into account, among which are current, voltage, power-factor, frequency, wave-form and temperature. A change in any one of the first three will directly alter the amount of energy flowing, and therefore the instrument must be extremely sensitive to variations in these quantities. The other three factors may be considered as of a disturbing nature and provision made to guard against possible inaccuracies from any of these sources. The effect of each of these factors on the performance of the instrument is reviewed. A short description is given of a modern type of induction watt-hour meter. —*Gen. Elec. Review*, April, 1915.

Dynamometric Ammeter and Voltmeter.—J. L. D. Ridsdale.—The author gives the theory of the dynamometric ammeter and voltmeter and discusses the conditions which must be fulfilled for the construction of a dynamometer which is to be correct both for alternating current and direct current.—From *Journal* (British) *Inst. Elec. Eng.*, Vol. 48, 1912, pages 515 to 583, abstracted in *Elek. Zeit.*, Feb. 25, 1915.

Telegraphy, Telephony and Signals

High-Voltage Arrester for Telephone Lines.—E. P. Peck.—The ordinary telephone with its fine wire coils, contacts, etc., is a very delicate instrument, and when used on lines paralleling high-tension transmission lines requires a protective device that will effectively shield it from the abnormal stresses resulting from a cross between the telephone line and the transmission line, a stroke of lightning, etc. The author describes a telephone lightning arrester, built in three sizes, which will adequately protect the instrument on transmission systems operating at pressures up to 250,000 volts or higher.—*Gen. Elec. Review*, March, 1915.

Cable Telegraphy.—H. W. Malcolm.—The continuation of his long mathematical paper on the future progress of telegraphy. The author discusses attenuation in a distortionless cable and points out that two weighty objections appear to the practical introduction of the distortionless cable. The first is that the extremely low insulation resistance which is entailed by the distortionless condition, even with high values of the inductance, would render testing and maintenance of the cables a matter of extreme difficulty; the second is that unless the inductance is high, freedom from distortion is purchased at the expense of enormous attenuation. He then takes up the case of the lightly loaded cable and investigates the effect on concentration of inductance at the ends of the cable.—London *Electrician*, March 19, 1915.

Book Reviews

The "Mechanical World" Electrical Pocket Book for 1915. Manchester, England: Emmott & Company. Baltimore: The Norman, Remington Company. 240 pages, 129 illus. Price, 50 cents.

This volume represents a thorough revision of the preceding annual editions. New sections are given on electric circuits and switching, synchronizing and phasing out, troubles of alternating-current motors and generators, etc. The section on electricity on shipboard has been extended and rewritten, and new matter has been added on the subjects of electric lamps and lighting, motor starters, and electricity in coal mines. The book contains also a varied collection of useful mathematical and electrical tables, making it a handy reference for engineers and others engaged in electrical work.

The "Mechanical World" Pocket Diary and Year Book for 1915. Manchester, England: Emmott & Company. Baltimore: The Norman, Remington Company, 330 pages, 85 illus. Price, 50 cents.

The 1915 edition of this annual publication contains the tables of logarithms, squares and cubes, weights of materials, etc., that are usually given in pocket books. In addition to the standard material of the preceding editions new sections are included on the steam turbine, the use of the milling machine, the grinder and the gear cutter, and new tables on the dimensions of keys, hydraulic packing, weights of finished nuts and set screws, etc. The sections on gas and oil engines and suction gas producers have been revised extensively. The volume is intended primarily for British engineers, but it contains a great deal that is of general interest and value.

Books Received

Oxy-Acetylene Welding and Cutting. By Calvin F. Swingle. Chicago: Frederick J. Drake & Company. 190 pages, 96 illus.

Preventing Losses in Factory Power Plants. By David Moffat Myers. New York: The Engineering Magazine Company. 560 pages, 68 illus. Price, $3.

Handbook of Machine-Shop Management. By John H. Van Deventer. New York: McGraw-Hill Book Company, Inc. 374 pages, 244 illus. Price, $2.50.

Pocket Edition of Diagrams and Complete Information for Telegraph Engineers and Students. By Willis H. Jones. New York: Telegraph and Telephone Age. 464 pages, 227 illus. Price, $2.

POWER AND OPERATING SECTION

Detecting Waste of Fuel Through the Ash-Pit

SOME of the heat losses that occur in the operation of steam boilers are exceedingly difficult to determine, and some can be detected only by the use of special instruments. Among the more obvious losses, however, is the one due to the presence of unconsumed coal in the ashes. If the firing is done by hand and stationary or shaking grates are used, the loss in this way may be due to carelessness in cleaning the fires, or more rarely to the use of grates having air spaces too wide for the grade of coal being burned. If chain-grate stokers are employed and they are unsuited to the size of coal used, there is apt to be considerable dropping through of the finer portions of the fuel, on account of the continual movement of the fuel bed; moreover, improper regulation of the speed of the grate may cause some of the coal to be carried over the end and dumped into the ash-pit before combustion has been finished. If this loss of fuel assumes considerable proportions, it can probably be detected by a mere ocular examination of the ashes, but in most cases a combustion test of a sample will have to be made. It is not a difficult matter to weigh a dry sample accurately in a crucible, subject it to the action of the flame of a blast lamp until all combustible matter remaining in it has been burned, cool it, and weigh it again carefully. The loss in weight divided by the weight of the sample will be the percentage of combustible matter contained in the ash, and if the percentage of ash in the coal is known, as it will be from the analysis, the loss due to the throwing away of unburned coal can easily be determined. Investigations of the composition of the ashes in this manner would probably yield surprising results for many firemen who believe that they are performing their work with more than average ability.

Economy in Small Plants

IN an article in this issue Prof. George C. Shaad deals with a subject which should appeal to many a worried engineer. No small task is more irritating than that of trying to wring economy out of a small electrical generating plant. As is perfectly well known, the small reciprocating steam engine, except that of the locomobile type, is usually a miracle of inefficiency. A close investigation of the guarantees makers are willing to give on small steam turbo-generators indicates that with them the conditions are almost as bad. Hence Prof. Shaad's data on oil engines are peculiarly welcome. From his showing it is feasible in working with oil engines of 100 hp and upward to produce a kilowatt-hour for a little over one pint of oil. With crude oil at a dollar a barrel or less, a kilowatt-hour costs not over 4 mills for fuel. If in using a Diesel engine such results as these can be consistently duplicated, one can reach a fuel economy substantially as good as can be attained with a large modern turbo-generating plant, thus bringing the large station and the small station fairly near together in cost of energy at the switchboard. Of course, the internal-combustion engine suffers somewhat in light-load efficency as compared with steam turbines, but it is so much more efficient than any available steam-driven unit of similar size that very much may be said in its favor. In spite of this well-known weak point, the rotative speeds attainable with such engines are sufficient to permit the use of fairly economical directly connected generators, and the total cost of the plant, while by no means low, still compares well with that of a steam plant of considerably less efficiency. The oil-engine plant is compact, requires no large expense for buildings or stack, and can be put into service very promptly when necessary. From all accounts it seems to be as dependable as steam, and while possibly subject to a somewhat greater depreciation it can well afford a fair depreciation charge on the basis of its very high thermodynamic efficiency. Perhaps the ultimate solution of the small-plant problem is the purchase of energy from widely ramifying distribution systems to which energy can be very cheaply supplied from large stations. Nevertheless, there are, and probably will be indefinitely, a good many cases in which an efficient small plant is greatly to be desired, and the recent figures from two excellent examples of oil-engine practice in Kansas point a moral that one will do well to remember.

Power Required for Driving Machine Tools

THE selection of a motor of enough power to drive a machine tool or a group of tools is a subject of unflagging interest, which has caused a great deal of discussion. However, in all that has been written concerning it, no short and simple general formula has been offered. The reason for this state of affairs is not hard to find. The conditions under which machine tools operate are so diverse and the factors that must be taken into account in determining the cutting resistance vary so greatly that a hard and fast rule is an utter impossibility. An idea of the number and nature of these variable factors can be obtained from a study of the chart presented by Mr. Alexander Dawes DuBois on page 928 of this issue. He shows that the power required to remove metal depends on the material being worked, the cross-sectional area of the chip, the shape, setting and condition of the cutting tool, the curvature of the work, and the cutting speed. In view of all these variable quantities, it becomes readily apparent that any

rule or formula which would take account of the individual effects for the purpose of showing their effects when acting conjointly would of necessity be extremely cumbersome and involved. The end aimed at by most experimenters along the line indicated has been to obtain reliable data covering a wide range of feeds, speeds and depths of cut on different materials, and to combine these data in the form of constants to be substituted in power formulas of reasonable simplicity. Such a method has been followed by Mr. DuBois. With the fundamental horse-power formula as a basis, he derives a formula for the power required to remove metal, in which there are just three variables—the cutting speed, the area of cross-section of the chip, and the cutting stress per square inch of chip section. The values of the first two of these variables may be selected to suit the given working conditions. The third, or the cutting stress, is taken from suitable tables based on the results of Nicolson's experiments, and in it is included the effect of the variation of the angle of inclination of the cutting tool. The result is that the useful power required may be calculated for any set of conditions within the range of the tabulated values. Then, knowing the efficiency of the tool as a whole, or the power required to drive it when empty, the total power needed is readily calculable. The article by Mr. DuBois is logically and concisely presented and will well repay careful reading by anyone interested in this subject, about which all too little of a definite nature has been printed.

Small Motors

The paper recently read by Mr. Bernard Lester at a meeting of the American Institute of Electrical Engineers held under the joint auspices of the industrial power committee and the Cleveland Section, abstracted elsewhere in this issue, deals with the characteristics of the very small motors and may be considered peculiarly timely, since the last two or three years have witnessed a great increase in the application of motors to small independent machines. The value and convenience of motor drive even for very small machines have been thoroughly appreciated for many years past. More than twenty years ago a project was formulated for the construction of so-called industrial buildings, a feature of which was to be the provision of a modest amount of motive power included in the rent or furnished at a nominal price. We are not aware that this excellent scheme was ever carried out, but it had the germ of a great idea for the universal use of electric power. If one tries to analyze the reason why a greater development of the small motor field did not take place long ago, he will find that two chief factors co-operated to hinder progress—first, the high price ordinarily charged for electricity in small amounts, and, second, the absence of cheap and reasonably efficient machines to do the work. Many years have been needed to wean the central station from the doctrine that the only profitable consumer is the big consumer, and it has been equally difficult to persuade manufacturers of electrical apparatus that they cannot saddle upon small industrial motors made in quantity the same overhead charges which they put upon new designs for 1000-kw generators. However, time has wrought its perfect work, and now not only do the central stations gladly quote reasonable prices to even small consumers, but the manufacturers of motors have realized that in the production of a large output of machines which are intrinsically standard there lies much profit.

As years have gone on, small direct-current motors of high quality have been built by a great many manufacturers, the only real difficulties being encountered in the small alternating-current motors. Of course, in anything except the most diminutive motors three-phase apparatus of good quality was to be had, but the applications considered by Mr. Lester are those requiring small, compact, light and cheap motors which can be run freely on any single-phase alternating-current circuit which happens to be at hand, and preferably on direct-current circuits as well. The series alternating-current motor meets these requirements rather well, but experience seems to have shown that the advantage of being able to run the same machine on both alternating-current and direct-current circuits is, on the whole, not very important if the machines are otherwise interchangeable. Chief reliance is now placed in small split-phase or repulsion motors, quite efficient and with reasonably good starting torque, obtainable at a price which enables them to be readily used for a multitude of purposes.

As Mr. Lester points out, one may regard small motor practice as involving all the problems of large industrial practice and requiring intelligent treatment. The small motor, like the big one, must meet at times extreme requirements of load. It may run continuously or intermittently, may have a high load-factor or a low one and must make good at all times, none the less because it happens to be rated at 0.1 hp instead of 10 hp. In the small motor the central station finds a desirable addition to its load. The motor rated at from 0.1 hp to 0.25 hp can be operated on any circuit without thought of difficulties. The small motor is a reliable earner of profits. As a general rule, the small motor load does not interfere with the peak load as much as does that of the larger motors, and the diversity-factor when the load is considered as a whole is of a most satisfactory character. Within the last few years so many well-designed small motors have found their way into favor that no difficulty is encountered in obtaining the proper drive for almost any small machine. What is more, the cost of these motors has consistently decreased until at last the business has reached a fairly sound commercial basis. Fractional-horse-power motors are turned out by the thousand and sold over the counter, so to speak, as standard articles at a reasonable price. From the standpoints of both operative efficiency and sound station economics, the small motor business deserves all possible encouragement, and it is a pleasure to record so instructive a discussion of its possibilities as that which Mr. Lester has given us.

Small Electric Generating Stations

Applicability of Oil Engines for Plants in Small Towns and Economy Secured by Their Use

BY GEORGE C. SHAAD

KANSAS, in common with other states in the Middle West, has a large number of relatively small cities, many of which own and operate municipal electric-lighting plants, often in conjunction with the city water-works systems. With improvement in the economy of incandescent lamps and the development of internal-combustion engines which use cheap fuel and are suitable for driving generators, electric plants are being installed in towns of only a few hundred population. The citizens of these towns are now enjoying long-hour service at rates which are comparable to those offered in the larger cities.

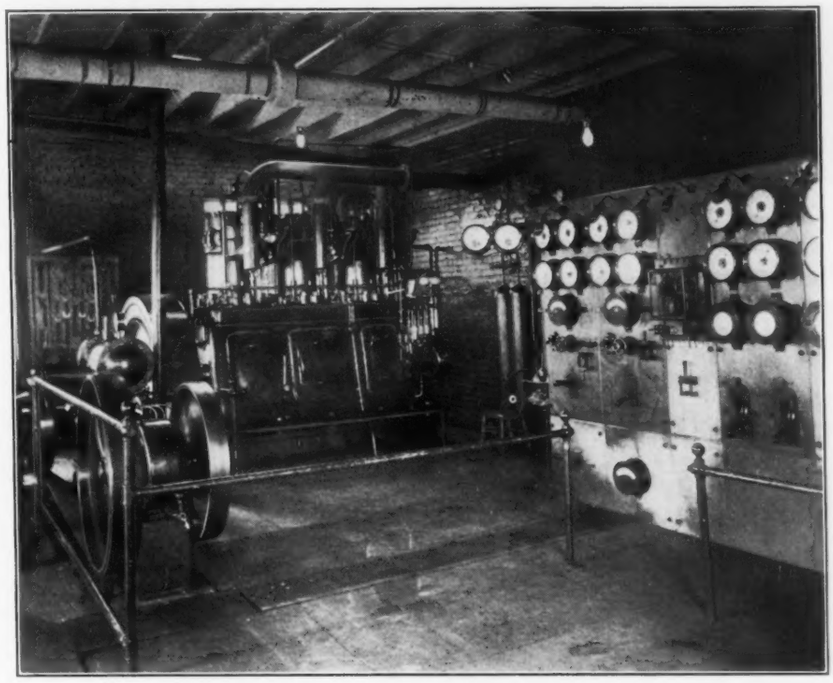


FIG. 1—OIL ENGINE DRIVING LIGHTING AND PUMPING STATION AT KIOWA, KAN.

The majority of these Kansas towns are too small to attract outside capital for the construction and operation of electrical plants, hence it is only through municipal ownership that electricity can be supplied. A comparatively few years ago such cities as were able to install generating stations put in steam equipment designed to be operated but a few hours each day; but the demand for longer hours of service soon caused these stations to be run throughout the twenty-four hours, and the result was very poor economy in operation. Such plants have in many instances been forced to install machinery which will lower the operating costs, even though the amount of the investment is considerably increased on account of the change.

Kiowa, Kan., with a population of 1500, is an example of a town in which the operating expenses of the steam-driven municipal lighting and water plant were very high. Here the steam machinery has been laid aside to be used in case of emergency only, a Diesel oil-engine unit having been installed to carry the load regularly.

The original installation at Kiowa was made in 1908 and consisted of two 16-ft. by 6-ft. horizontal-return tubular boilers and a 13-in. by 12-in. simple, high-speed engine directly connected to a 75-kva alternator. Later, a 15-in. by 14-in. simple, high-speed engine directly connected to a 100-kva alternator was added. At the close of the year 1913 the electrical plant consisted of the units as listed. The pumping equipment comprised an 8-in. by 8-in. induction-motor-driven triplex pump placed at the wells about one-half mile from the plant and some 55 ft. below it, and two 8-in. by 12-in. by 10.25-in. by 10-in. compound duplex steam pumps used for pumping water from a reservoir at the plant to the elevated tank of the distribution system. The plant was operated twenty-four hours a day with a peak load of less than 65 kw and a day load which was scarcely indicated by the switchboard meters. With coal at $2.75 a ton or oil at $0.98 per barrel at the plant, the fuel costs for the last six months of the year 1913 averaged $466.78 per month, or nearly 5 cents per kw-hr. at the switchboard.

Some saving could have been made by changes in the methods of operating, but conditions were such that the fuel costs, with coal or oil used under the boilers, would always be very high. It was decided, therefore, to put in a 120-hp three-cylinder, vertical-type Busch-Sulzer Brothers Diesel engine, directly connected to a 100-kva alternator, running at 225 r.p.m. This unit, placed in operation in October, 1914, is now used almost continuously. It is shut down only for a few hours on Sunday morning, at which time it is carefully inspected and necessary adjustments are made. The smaller steam-engine unit has been sold, but the larger unit is kept to be used in case it becomes necessary to shut down the oil-engine unit. One of the steam pumps has been

replaced by a 350-gal.-per-minute triplex pump, driven by a 30-hp induction motor.

At the time of the acceptance tests at Kiowa a twenty-four-hour run under regular operating conditions was made, no adjustments of the engine with a view to obtaining maximum fuel economy being permitted. The load curve for this run is given in Fig. 5. The switchboard output amounted to 650 kw-hr., and the fuel consumption, using fuel oil costing 2 cents per gallon delivered at the plant, amounted to 0.149 gal. per kw-hr. On this basis the operating expense for fuel has been reduced from approximately 5 cents per kw-hr. to less than 3 mills per kw-hr. Fig. 3 shows the limited space which was available for the new unit without extending the power-plant building, and Fig. 1 gives a view of the new unit as it was finally installed.

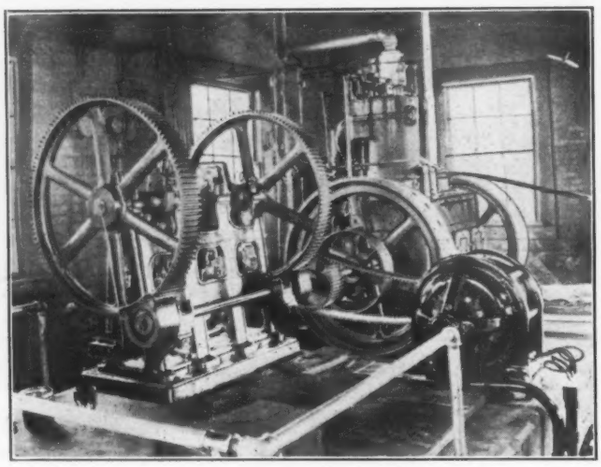


FIG. 2—MOTOR-DRIVEN WATER-WORKS PUMP AND AN 80-HP DISTILLATE ENGINE

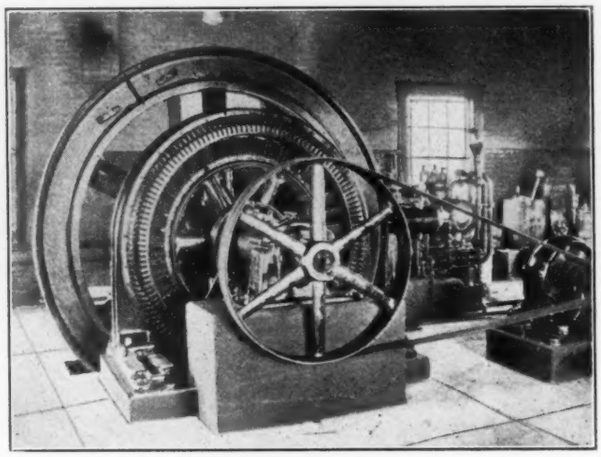


FIG. 4—SINGLE-CYLINDER 100-HP OIL ENGINE AND GENERATOR AT COLDWATER

Coldwater, Kan., with a population of 1000, is another illustration of a town in which a small and relatively inexpensive plant giving service but a few hours a day has been rehabilitated. By the addition of a more expensive generating unit the hours of daily operation have been increased to eighteen and probably will be extended to twenty-four in the near future.

Here the original electric installation, made in 1911, consisted of an 85-hp three-cylinder, vertical type of internal-combustion engine, belt-connected to a 50-kva alternator, and using distillate fuel, but not capable of operating on the heavier oils. The pump for the water-works system was driven directly by the engine through a friction clutch. The plant was operated during the evening and early morning hours and on an occasional forenoon for the accommodation of patrons having electric flatirons.

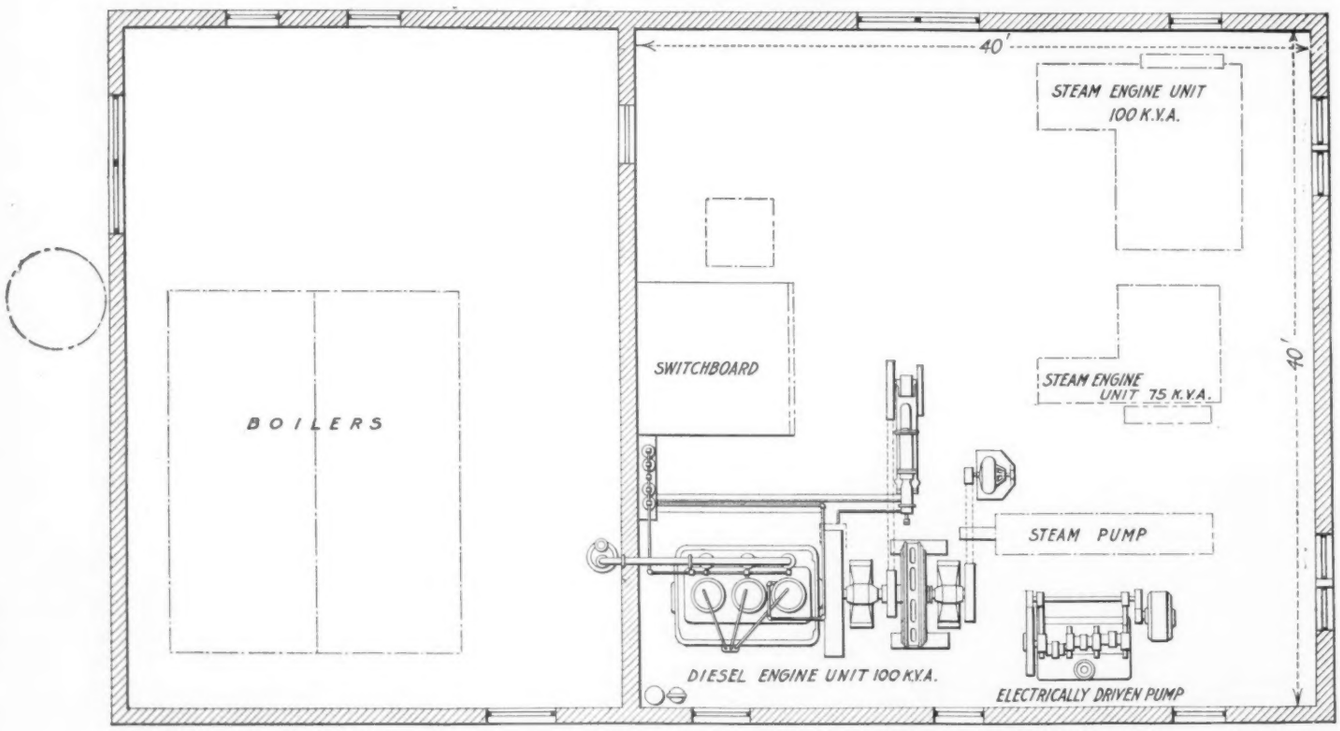


FIG. 3—PLAN OF POWER PLANT, COMPARING SPACE OCCUPIED BY STEAM AND OIL-ENGINE EQUIPMENT

The maintenance expense for this unit was high, and it was decided, therefore, to put in a large and more expensive unit for regular operation, the distillate

engine outfit to be held for emergency use only. Accordingly a 100-hp single-cylinder, horizontal De La Vergne oil engine, directly connected to a 100-kva Fort Wayne alternator, was purchased, and a 25-hp induc-

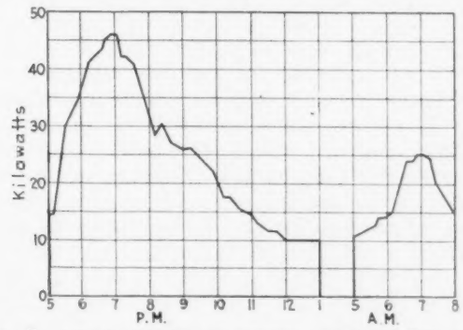


FIG. 5—LOAD CURVE AT KIOWA, OCT. 24-25, 1914

tion motor was installed to drive the water-works pump through a chain belt. The new unit was started in November, and a test for one day of normal operation

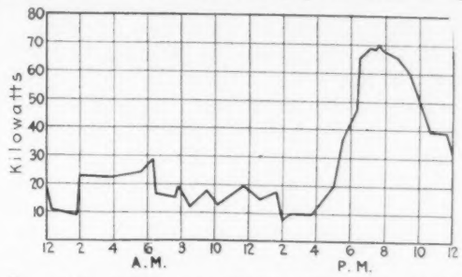


FIG. 6—LOAD CURVE AT COLDWATER, NOV. 11-12, 1914

showed a fuel consumption of 0.149 gal. per kw-hr. Heavy fuel oil costing 48 cents a barrel was used. Fig. 6 illustrates the load curve for this plant, and Fig. 4 shows the new unit as it was installed.

The Lubrication of Ball Bearings

BY ARTHUR V. FARR

The more general use of ball bearings on electric motors has brought up a number of questions on the proper means of lubricating them: "Should I use oil or grease in my ball bearings?" "What kind of lubricant should I use?" One user of ball-bearing motors stated his question as follows: "I have been offered two grades of grease for use on the ball bearings of my machine. To me these two greases look the same, yet one costs almost twice as much as the other. How can I tell a good grease?" The purpose of this article is to answer these questions.

It should be recognized at the outset that although ball bearings must always be lubricated, the lubricant in a ball bearing performs a function different from the one it performs on plain bearings. In plain bearings the lubricant is used to keep a film between the shaft and the bearing lining, and this film must be maintained constantly in order to prevent wear and heating. The purpose of a lubricant in a ball bearing, however, is merely to preserve the highly polished surfaces of the balls and races. The balls and races are always in point contact, which necessarily means metal-to-metal contact. As a general principle, it might be stated that any lubricant that will not cause rust or destroy the polished surfaces of the balls and races, and that will properly circulate through the bearing and lubricant chamber, will be satisfactory.

To preserve the highly polished surface of the steel balls and races, therefore, the lubricant must be chemically neutral; that is, it should be neither acid nor alkali. A good way to determine whether a lubricant is either acid or alkali is to place some of it on a highly polished steel surface for a time and then compare this surface with that of a similar sample which is still in its polished condition. If the finish has been at all attacked, the lubricant is not desirable. Use can also be made of litmus paper, which will change its color to pink if the lubricant is acid and to blue if the lubricant is alkaline.

It is also necessary that the lubricant should not undergo any chemical change owing to heat or other causes. In order to guard against such a change, it is, therefore, usual to employ a clean mineral oil or mineral fat of best quality.

It is also essential that the lubricant should not contain any solid particles which would cause wear, and the lubricant chamber should be so sealed as to prevent the entrance of dirt, grit or other foreign substances into the bearing. It is a quite usual occurrence to find that a bearing wears down owing to solid particles of dust, etc., having found their way into the lubricant.

From the above statements it is evident that, in all cases where one need consider only the actual lubrication of the bearing, a clean, thin mineral oil can be used to advantage. The greater the speed, the thinner the oil.

On the other hand, in those cases where there is a possibility of risk of exposure to dust, moisture or acids, the ball bearing should be protected by means of a solid grease. To insure proper protection, the whole housing around the bearing should be filled with this grease, which should be of such composition and consistency that the internal friction of the lubricant and the increase in temperature which may result by its use will not cause it to become fluid. For this reason pure mineral greases, such as vaseline, will often be found unsuitable, as they usually have a melting point of 86 deg. Fahr., and when melted are of about the same viscosity as water.

One should, therefore, in such cases select a solid grease of the very best quality—that is, it must have the lowest possible internal friction and, above all, be absolutely neutral so that there will be no risk in its attacking the polish surfaces of the bearing. Moreover, it should not contain resin or resin-forming matter. The presence of any large quantity of resin can be detected by the smell.

The solid grease suitable for ball bearings should contain about 90 per cent of mineral fat.

When the temperature of the bearing can rise to 140 deg. Fahr. and higher, the bearing should be lubricated with a thick flowing machine or cylinder oil.

For vertical shafts where no special arrangement has been made for reliable lubrication with oil it is, of course, necessary to use grease, and what has been said with regard to the use of solid grease in general, of course, also applies to vertical mountings.

Many machine manufacturers who use ball bearings make a practice of attaching a card with instructions printed thereon for the care of the ball bearings on the machines. These instructions do not go into detail at all, but they contain an excellent outline of the solution of the lubrication problem, as follows:

"To renew the lubricant in the bearing, remove the bearing cap, clean out all dry or caked grease, and wash out with gasoline or kerosene. Refill with a clean, fresh lubricant, being sure that the bearing and bearing housings are properly filled. Keep the lubricating and drain holes of the housing closed to prevent the leakage of lubricant or the entrance of dirt.

"Nothing but the purest mineral lubricant should be used, as any acid, grit, rust, etc., quickly ruins the highly polished surfaces of the balls and races, thereby materially shortening the life of the bearing."

STRESSES IN STEAM PIPES

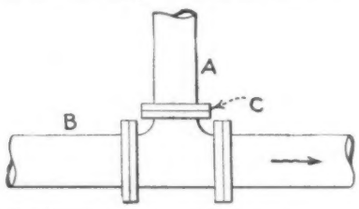
Forces Set Up by Expansion and Necessity of Providing for Them in Steam-Plant Practice

BY S. U. TUSPIN

When heat is applied to a piece of iron the first noticeable effect is a rise of temperature of the piece and the second is an increase of size on the part of the iron. All metals are affected in the same ways, but the degree to which they are affected depends on their composition. In order to compare the effects of heat in producing changes of size in pieces of metal, the degree of temperature is used as the basis. That is, the change of size is calculated per degree rise of temperature, and the Fahrenheit degree is commonly used.

Expansion under the action of heat takes place in all directions. If a block of copper is heated, its length, breadth and thickness are affected and the block increases in length, cross-sectional area and volume. The amount of increase of size per degree rise of temperature is called the coefficient of expansion, and as the expansion takes place in the length, area and volume of a piece, the coefficients are termed coefficients of linear, surface and cubic expansion.

In the steam plant the most important example of expansion under the application of heat is that of the



PIPE SUBJECTED TO LONGITUDINAL EXPANSION

pipes conveying steam. These pipes are erected while cold; that is, they are put up at the temperature of the surrounding atmosphere. When steam is turned into them their temperature is increased and they expand; but as they are very long in comparison with their diameter, the effect of the expansion is most noticeable in the direction of their length.

The following table gives the values of the linear coefficient of expansion for such metals as are apt to be encountered in the piping of a power plant:

Material	Coefficient
Cast iron	0.0000056
Wrought iron	0.0000065
Steel	0.0000065
Copper	0.0000090
Brass	0.0000095

It will be seen that these values differ, the reason being that some metals are more readily affected by heat than others. The value of the coefficient represents the increase per unit of length per degree Fahrenheit. That is, if a piece of cast iron 1 in. long is heated 1 deg. Fahr. it will increase 0.0000056 in. in length, or if it is 1 ft. long the increase of length will be 0.0000056 ft. In other words, the actual amount of expansion is found by multiplying together the increase of temperature in degrees Fahrenheit, the length of the straight line of pipe, and the proper coefficient for the material, as given in the table. If the length of the pipe is taken in feet the result will be in feet, and if it is taken in inches the result will be in inches.

As an example, suppose that a straight line of steel steam piping is 120 ft. long, that it is erected when the temperature of the air is 61 deg. Fahr., and that when the job is completed steam having a gage pressure of 140 lb. per square inch is turned into it. At a pressure of 140 lb. gage, corresponding to 155 lb. absolute, saturated steam has a temperature of 361 deg. Fahr. The increase of temperature is therefore $361 - 61 = 300$ deg., and the increase of length or the linear expansion of the piping is $300 \times 120 \times 0.0000065 = 0.234$ ft., or 2.8 in. Therefore, if one end of the line were anchored firmly, the other end would move endwise a distance of over 2¾ in., or, if the middle of the pipe were anchored, each of the ends would move outward about 1⅜ in.

On the other hand, if the ends of the pipe were held rigidly, as by being fixed in brackets or bolted to machines, the force that produced expansion would be resisted and there would be great danger of buckling the pipe, breaking the fittings and damaging the machines to which the pipe led. That such results might easily occur can be demonstrated by a calculation of the force of the expansion.

If the pipe were placed between two immovable posts or pillars and braced sidewise so that it could not buckle, the ends could not move and expansion could not occur; but the tendency to expand would still be present and the ends of the pipe would press with great force against the end pillars. The condition of the pipe would then be the same as would exist if, after the 2¾ in. of expansion had occurred, an endwise force had been applied to compress the pipe to its original length.

Now, it is possible to calculate very closely the force that is required to compress a piece of material a given amount. So, if we calculate the force required to compress a line of steel pipe from a length of 120.234 ft. to 120 ft., we shall know the force that the pipe exerts when under the conditions described.

The formula for calculating the force required to produce a certain amount of compression in a piece of material is

$$P = \frac{CAE}{L}$$

in which P = total force required, in pounds;
C = amount of compression, in feet (or inches);
A = cross-section of piece, in square inches;
E = modulus of elasticity for compression, which is 30,000,000 for steel;
L = length of piece, in feet (or inches).

For wrought iron the modulus of elasticity may be taken as 28,000,000 and for cast iron as 17,000,000.

To illustrate the application of the formula, suppose that the pipe previously considered is a 4-in. standard steel pipe. The cross-section of the metal in it is approximately 3.2 sq. in. Then, if it is compressed from 120.234 ft. to 120 ft., or a distance of 0.234 ft., the force required to accomplish that result must be

$$P = \frac{0.234 \times 3.2 \times 30{,}000{,}000}{120.234} = 187{,}000 \text{ lb., nearly.}$$

This enormous pressure, 187,000 lb., would be exerted as an end thrust by the steam pipe if it were held at both ends, and this accounts for the necessity of taking proper precautions when the steam pipe is installed, to allow any expansion to be taken up by springing of bends or by some other device. It also explains the reason for troubles that have developed in places where proper care has been overlooked in the erection of piping.

For example, suppose that a short and rigid branch pipe A (see illustration) is connected at the side of the main steam pipe B, and that the main pipe in expanding moves in the direction of the arrow. In such a case there will be a tendency to open the joint at the point C.

If valves are used in pipes similarly stressed, the distortion may be sufficient to cause them to leak or even to break. If a valve seat is warped, it is next to impossible to keep the valve tight.

If the main steam pipe is carried in a straight line over the tops of the boilers, with the boilers connected to it by short risers, the expansion may cause trouble. For the pressure exerted at right angles to the axis of the boiler will be transmitted through the shell to the side wall and may be sufficient to crack the brickwork.

These are a few of the troubles that may arise through neglect of means to care for expansion. But as the total expansion of a pipe depends largely on the number of degrees through which it is heated, pipes conveying superheated steam need even greater care in their arrangement than do those conveying saturated steam at ordinary pressures.

TESTING POLYPHASE WATT-HOUR METER

Method of Checking Which Avoids Disconnecting Instrument from Transformers

BY FRANK R. INNES

The determination of the correctness of the connections of a polyphase watt-hour meter while the meter is in use is sometimes extremely difficult. In case the meter is connected through instrument transformers to high-tension circuit, the operation is dangerous. When the power-factor of the load is known at least approximately, the correctness of the connections may be determined by comparing the reading of the watt-hour meter with the readings of the voltmeter and ammeter. However, when the power-factor is not known, the most satisfactory check of the connections of a polyphase meter is to identify each lead as coming from a definite secondary terminal on the series or shunt instrument transformer and going into its proper meter terminal; that is, a check which will furnish the same information as actually disconnecting, ringing out and tagging the secondary wiring.

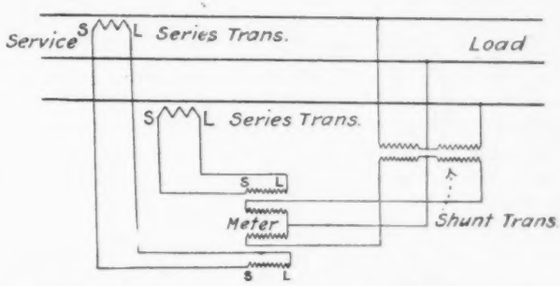
Such a method of checking, which avoids disconnecting the wiring between the transformer secondaries and the meter, consists in paralleling each secondary lead with a test lead and utilizing the current produced in this test lead by the secondary voltage to indicate the condition of parallelism. The accompanying illustration, which shows the proper connections for a polyphase watt-hour meter, will make clear the basis of this method.

The identification of the leads between the meter and the shunt instrument transformer secondaries is effected by connecting a lamp of the proper voltage in series with the test lead and one potential terminal of the meter, and by touching the free end of the test lead successively to each secondary potential terminal. The terminal at which the lamp remains "dead" is connected to that meter terminal to which the lamp is connected. Each secondary terminal is identified in like manner.

When two independent leads are brought from each of the two series transformers they may be identified as follows: First remove all known interconnections, such as grounds, etc. If the installation under check is a high-tension one, all of the precautions incident to the handling of ungrounded secondaries should be observed. Use should be made of a test lead having a resistance less than that of the secondary of the series transformers, no lamp, of course, being used in this case. The end of this test lead should be connected to one meter terminal and the free end of the lead should be touched successively to each secondary terminal of the series transformers, note being made of the sparks. On one transformer a slight static discharge will probably be observed at each terminal, on the other a current discharge through the short-circuit formed by the test lead will be seen at one terminal, and at the last terminal there will be no spark. This "dead" terminal is then the one connected to that meter terminal to which the test lead is attached. The same procedure is to be followed in the identification of each secondary lead.

A current discharge at one terminal on each transformer indicates a connection between the secondary coils; this connection should be removed, or, if that is difficult, the procedure described below for the three-wire, or common-return, secondaries should be followed. If two of the secondary terminals remain absolutely dead and a heavy flaming discharge is seen at the other two, the two secondaries are connected in series through the two series elements of the meter. Such a connection is, of course, wrong and should be rectified.

When the three-wire or the common-return system is used for the series transformer secondaries, the same procedure should be followed, the test lead being connected to one meter terminal and the free end touched successively to the secondary terminals of the series transformers. If the connections between the meter and the transformers have been properly made, a current discharge will be noted at two of the transformer terminals. To ascertain to which series transformer the meter element connected to the test lead is connected, short-circuit one transformer at the secondary terminals and touch the end of the test lead to the terminals of the other. If a spark is observed, the second transformer is connected to the meter element under check, and the identity of the lead under check is determined by noting which transformer terminal remains "dead." If no spark is observed at either terminal, the short-circuit should be moved to the second transformer and the test repeated. If a spark is seen at each transformer while the other is short-circuited, the test lead is connected at the meter to the common return.



CONNECTIONS FOR TESTING WATT-HOUR METER

It may happen, in the event of the installation under check being without load or operating at extremely light load, that the sparks at the series transformer may not be perceptible or may be indistinguishable from static discharges. In this case the voltage of the secondary may be increased by the introduction of reactance into the secondary circuit. The writer has not found this expedient necessary, however, in his use of the method.

After the connection of each lead has been checked in the manner prescribed and properly identified as belonging to a particular secondary terminal on the series or shunt instrument transformer the proper connections at the meter can readily be made.

In checking the leads as above described, it must be remembered that an ungrounded instrument-transformer secondary should be handled with the same caution as would be accorded to the line primary circuit. It is also well to keep in mind that a closed series transformer secondary is comparatively innocuous, but an open one must be treated with respect.

Power Formulas for Machine Tools

Based Upon Experiments Carried on in England and Upon Others at the Engineering Experiment Station of the University of Illinois

By Alexander Dawes DuBois

THE problems involved in the selection of electric motors for any industrial service are primarily the determination of power requirements and the choice of suitable operating characteristics. The determination of the power requirements is in some cases a matter of simple and definite tests. The machines to be motor-equipped are belted to a portable motor, the input of which is readily measured and the output as readily calculated. But this procedure is not always practicable, and then recourse must be had to other means.

When the necessary apparatus is not available, or when for other reasons it is not feasible to make a power test of each machine, the required power must be determined either by calculation from an established formula or by reference to compiled data covering similar machines. There are some machines which defy any attempt to calculate the power required, because the working forces are unknown and cannot be directly measured. It will sometimes be desirable to estimate the power as nearly as may be by formula, and then, before coming to a final decision, to compare the result with available tests and data of other machines operating successfully under similar conditions.

General Formula

Whenever it is possible to reduce the functions of a machine to a force and a distance traversed per minute by that force, the calculation of power becomes simple and definite.

Let F = force in pounds;
S = distance in feet per minute traversed by force F;
Hp = horse-power.

$$\text{Then Hp} = \frac{FS}{33{,}000}. \qquad (1)$$

To the power thus calculated must be added a suitable percentage to cover friction losses in the machine itself, unless the frictional forces have been included in the term F used in the calculation.

Hoisting and Pumping Machinery

As an illustration of the direct application of the power formula the case of hoists and lifts may be cited. For this class of apparatus F is the weight to be hoisted, in pounds, and S is the speed of hoisting in feet per minute. Hence the useful horse-power is $\frac{FS}{33{,}000}$. To this must be added the power lost in overcoming the friction of journals, pulleys, ropes, etc., in the apparatus. If these losses are assumed to be equal to the useful power—that is, if the efficiency of hoisting is assumed to be 50 per cent—the result will not be far wrong in the great majority of cases, including contractor's hoists, passenger and freight elevators, etc.

With pumps of all types the weight of water lifted and the rate at which it is raised constitute the two terms F and S of the power equation. With this principle in view the formulas for fresh water at 62 deg. Fahr. will be found to reduce to the following convenient forms:

Let G = gallons discharged per minute;
Q = cubic feet discharged per minute;
P = pressure at pump in pounds per square inch;
H = head in feet, including suction head.

$$\text{Then Hp} = \frac{GP}{1714.5} = \frac{QP}{229.2}. \qquad (2)$$

Or, in another form, substituting head for pressure,

$$\text{Hp} = \frac{GH}{3958.7} = \frac{QH}{529.2}. \qquad (3)$$

If 4000 is substituted for the constant 3958.7, the error will not exceed about 1 per cent.

In arriving at the size of motor required the useful horse-power calculated as above must be divided by the efficiency of the pump, guaranteed by its manufacturer, and to this result must be added the power necessary to overcome the friction head due to pipe line, elbows, etc., in both the suction and discharge lines of piping.

In equipping centrifugal pumps with motors there is an important consideration which is in danger of being overlooked. It is the seemingly anomalous fact that, with a constant speed of operation, a reduction of the head pumped against will increase the load on the motor. For, according to equation (3), the power varies directly as the product GH. But the volume discharged varies inversely as the square of the head; that is, G varies as $\frac{1}{H^2}$. Hence, the power varies as $\frac{1}{H^2} \times H = \frac{1}{H}$, or inversely as the head. When a motor-driven centrifugal pump at constant speed is subject to variation of head with uncontrolled discharge, it is therefore essential to investigate this point and to provide a motor large enough to take care of the increased discharge at the minimum head or else to provide a variable-speed motor so that the load may be kept within limits by reducing the speed at the low heads and thus controlling the discharge. It is evident, also, that an overloaded constant-speed motor could be relieved of its overload by increasing the head or introducing a friction head, provided a decrease of discharge were permissible. The head against which a centrifugal pump will discharge is proportional to the square of the speed of the impeller blades.

The following data, based on fresh water at 62 deg. Fahr., will be found convenient to use in making pumping calculations:

One U. S. gallon = 231 cu. in.
= 8.335 lb. of fresh water.
= 8.552 lb. of sea water.

One British imperial gallon = 277.463 cu. in.
= 10 lb. of fresh water.
= 10.26 lb. of sea water.
= 1.201 U. S. gal.

One cubic foot of fresh water = 7.4805 U. S. gal.
= 6.228 imperial gal.
= 62.355 lb.

One foot head of fresh water = 0.433 lb. per square inch.

One pound per square inch = 2.309 ft. head of fresh water.

Machine Tools

The power required for machine tools such as lathes, boring mills, planers, shapers and slotters, which remove metal through the agency of a cutting tool, is not so easily calculated. To apply the general formula to an engine lathe, for example, it is necessary to know not only the velocity of cutting, which is easily determined, but also the vertical component of the forces

acting upon the tool point, which is a quantity involving many considerations. In the accompanying chart is presented an analysis indicating the factors which influence the power requirements appertaining to this class of machines.

The total power delivered to the machine is shown under two main heads as useful power and wasted power. The useful power is the product of the tangential cutting force and the velocity of cutting; hence it is shown divided into these two factors, each of which depends upon a number of attributes and conditions that are in a general way indicated in the chart. In a similar manner the wasted power is the product of the total frictional torque and the angular speed. The last-named factor requires no further analysis; but the frictional torque is made up of moment arms and forces which depend upon a multitude of details. The chart is presented merely as an introduction to the problem of power formulas—a bird's-eye view of the various considerations. It is apparent that no practical formula could be expected to express mathematically the wasted power in machines of this class. The formulas in general use are intended to express the useful power, which depends upon the forces acting on the cutting tool.

Nicolson's Experiments

Prof. J. T. Nicolson,[1] at the Municipal School of Technology of Manchester, England, carried out a series of experiments which throw so much light upon the question of the forces acting upon the cutting tool as to justify the presentation here of a summary of the results, in so far as they bear upon the subject of power consumption.

The materials operated upon were of three grades: (1) Medium cast iron, somewhat harder than ordinary

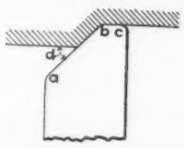


FIG. 1—PLAN OF TOOL USED IN NICOLSON'S EXPERIMENTS

shop cast iron; (2) soft fluid-pressed steel, tough but not hard; (3) medium fluid-pressed steel. The machine used for the tests was a heavy high-speed engine lathe. The force measurements were read by means of a set of ingenious lathe-tool dynamometers of hydraulic type, designed by Professor Nicolson, and so applied that one Bourdon gage indicated the vertical component, another the traversing component, and a third the surfacing component of the total force upon the tool point. The cutting tools were made of 1¼-in. square steel ordinarily, although 1½-in. and 2-in. square steel was used in some of the tests. Air-hardening high-speed tool steels of various makes were employed.

The general form of the tool used is shown in plan in Fig. 1. The cutting edge *ab* was kept horizontal in all tests. The top surface of the tool was a plane containing the cutting edge and inclined at an angle, called the cutting angle, to a vertical plane through the cutting edge. The cutting edge terminated at a point *b*, ⅜ in. from the right-hand corner *c* of the tool (in 1¼-in. tools) so that the average cut would give a downward thrust acting as nearly as possible at the center line of the tool and thus prevent any twisting action. The nose of the tool had a clearance angle in plan of not less than 1 deg., and a small radius was ground on the corner between the two edges. The front clearance was 6 deg., the tool being used with the cutting edge set level with the center line of the work.

Several of the terms used in connection with the cutting tool have special meanings, as follows:

Plan angle is the angle between the cutting edge of tool and the axis of the work, shown at *d*, Fig. 1.

Cutting angle is the angle at which the top surface of the tool is inclined to a vertical plane through the cutting edge.

Cutting force, or vertical force, is the force acting vertically downward upon the tool point; it is the vertical component only of the total force acting upon the point of the tool.

Cutting stress is the quotient of the cutting force divided by the area of the cut; or, in other words, it is the cutting force per square inch of area of chip removed.

Traversing force is the force acting upon the tool point in a horizontal line parallel to the axis of the work, and may be either positive or negative. In the latter case it would tend to draw the tool into the work. The traversing force is the force which must be overcome in feeding the tool along the work.

Surfacing force is the force acting upon the tool point in a horizontal line perpendicular to the axis of the work. It may be either positive or negative. It is the force which must be overcome in feeding the tool radially into the work, or in merely preserving a constant depth of cut.

The ratio $\frac{F_t}{F_v}$ is the ratio of the traversing force to the vertical force.

The ratio $\frac{F_s}{F_v}$ is the ratio of the surfacing force to the vertical force.

Schedule of Tests and Results

1. *Variation of Cutting Force with Area of Cut.*
   A. For medium cast iron.
      Constants: Cutting speed = 25 ft. per minute.
      Plan angle = 45 deg.
      Variables: Cutting angle = 45, 60, 75 and 90 deg.
      Traverse = 1/16, ⅛, ¼ and ⅜ in.
      Depth of cut = ⅛, ¼, ⅜ and ½ in.
   B. For soft steel.
      Constant: Cutting speed = 50 ft. per minute.
      Other conditions same as for cast iron.
      Results: For both cast iron and steel.

For a given traverse the cutting force seems to be simply proportional to the depth of cut. In other words, the cutting stress is constant for a given tool angle and given width of traverse, regardless of depth of cut.

2. *Variation of Cutting Stress with Speed of Cut.*
   A. For soft steel.
      Constants: Plan angle = 67½ deg.
      Cutting angle = 55 deg.
      Cut and traverse = ⅜ in. by ⅛ in.
      Variable: Cutting speed, from 0.0033 ft. to 84 ft. per minute.

Results: The cutting stress decreases constantly with an increase of speed up to 84 ft. per minute, notwithstanding that the same tool was used throughout the tests without regrinding.

At a cutting speed of 10 ft. per minute the cutting stress is 193,760 lb. per square inch. It is practically a straight-line function of the speed from this value down to 175,840 lb. per square inch at a speed of 84 ft. per minute.

At the "dead slow" speed of 1 ft. in four and one-half hours the stress is about 253,120 lb. per square inch.

At 84 ft. per minute the tool was removing metal at

[1] "Experiments with a Lathe-Tool Dynamometer," a paper read at the Chicago meeting of the Institution of Mechanical Engineers in 1904.

the rate of 12.3 lb. per minute, but it failed in one minute twelve seconds.

3. *Variation of Cutting Stress with Cutting Angle of Tool for Different Traverses.*

A. For medium cast iron.

Constants: Cutting speed = 25 ft. per minute.
Plan angle = 45 deg.

Variable: Cutting angle = 45, 60, 75 and 90 deg. Separate test as above for each traverse of 1/16, ⅛, ¼ and ⅜ in. respectively.

Results: Variation of cutting stress with cutting angle is very marked. Its smallest value takes place in every case with a cutting angle of about 60 deg. It varies by nearly 100 per cent of its smallest value for angles below 90 deg.

TABLE I—VALUES OF P FOR MEDIUM-HARD CAST IRON, FROM NICOLSON'S EXPERIMENTS

Cutting Angle in Degrees	Cutting Stress P in Pounds per Square Inch	
	1/16-in. Traverse	¼-in. Traverse
45	160,200	125,500
60	128,900	114,200
75	171,400	163,600
90	216,000	177,000

Note.—Depth of cut did not materially affect P. Plan angle of tool 45 deg. throughout.

At a cutting angle of 80 deg. the cutting stress is about 168,000 lb. This is the most durable angle for shop use, as shown by endurance tests.

Somewhat lower cutting stress for wide than for fine traverses, although this does not seem always to hold for the keenest cutting angles.

B. For soft steel.

Constant: Cutting speed = 50 ft. per minute.
Other conditions same as for cast iron.

Results: At a cutting angle of 75 deg. the stress is the same whether the traverse be 1/16 in. or ⅛ in. and has a value of about 224,000 lb. per square inch. This angle is also about the best angle for shop use as shown by the durability tests. Hence such a tool exerts a force of 224,000 lb. per square inch, regardless of the relation between cut and feed.

For keen cutting angles (below 75 deg.) fine traverses require less cutting stress than wide ones.

TABLE II—VALUES OF P FOR SOFT STEEL (FLUID-PRESSED), FROM NICOLSON'S EXPERIMENTS

Cutting Angle in Degrees	Cutting Stress P in Pounds per Square Inch	
	1/16-in. Traverse	⅛-in. Traverse
45	219,500	197,100
60	174,800	143,400
75	221,800	221,800
90	266,500	351,800

Note.—Plan angle of tool 45 deg. throughout.

For cutting angles greater than 75 deg. fine traverses require greater cutting stress than wide ones.

Smallest value of cutting stress is at cutting angle of 60 deg., as for cast iron.

4. *Variation of F_v, F_t and F_s with Plan Angle of Tool.*

A. For soft steel.

Constants: Cutting speed = 50 ft. per minute.
Cutting angle = 55 deg.

Variables: Plan angle = 22½, 45, 67½ and 90 deg.
Depth of cut.
Traverse.

Results: $\frac{F_t}{F_v}$ varies but little and somewhat irregularly, though for light cuts it seems to have a minimum value at about 45-deg. plan angle. The traversing force is of less importance than the surfacing force.

TABLE III—VALUES OF THE CONSTANT C FOR MEDIUM CAST IRON

Cutting Angle in Degrees	Values of Constant C	
	1/16-in. Traverse	¼-in. Traverse
45	0.0259	0.0203
60	0.0208	0.0185
75	0.0277	0.0265
90	0.0350	0.0286

$\frac{F_s}{F_v}$ is a minimum for tools with 45-deg. plan angle for all cuts. This minimum varies from 0.33 for light cuts to 0.18 for heavy cuts. $\frac{F_s}{F_v}$ rises to nearly 0.4 for angles smaller and greater than 45 deg.

5. *Variation of F_v, F_t and F_s with Cutting Angle of Tool.*

A. For soft steel.

Constants: Cutting speed = 50 ft. per minute.
Plan angle = 45 deg.

Variables: Cutting angle = 45, 55, 75 and 90 deg.
Depth of cut.
Traverse.

Results: Both $\frac{F_t}{F_v}$ and $\frac{F_s}{F_v}$ pass through minimum values at a cutting angle of about 55 deg.

The minimum values of $\frac{F_s}{F_v}$ vary from 0.25 for light cuts to 0.18 for heavier cuts. With a cutting angle of 90 deg. the ratio $\frac{F_s}{F_v}$ may reach 0.8 for light cuts.

$\frac{F_t}{F_v}$ is not so important as $\frac{F_s}{F_v}$, but it may reach a value of 0.2 with large cutting angles.

TABLE IV—VALUES OF THE CONSTANT C FOR SOFT STEEL

Cutting Angle in Degrees	Values of Constant C	
	1/16-in. Traverse	⅛-in. Traverse
45	0.0325	0.0292
60	0 0258	0.0212
75	0.0328	0.0328
90	0.0394	0.0520

$\frac{F_s}{F_v}$ diminishes and $\frac{F_t}{F_v}$ increases as the cut becomes heavier, as clearly shown by a series of readings all made with one tool having a 45-deg. plan angle and a 55-deg. cutting angle. This is very marked for light cuts up to 0.3 in. deep; but for heavier cuts the curves are nearly horizontal lines. For cuts less than 0.12 in. deep the force F_t was negative, the tool being drawn into the work.

6. *Endurance Tests of Different Cutting Angles.*

A. For medium cast iron.

Constants: Cutting speed = 44 ft. per minute.
Depth of cut = 3/16 in.
Traverse = 1/16 in.
Plan angle = 45 deg.

Variable: Cutting angle = 60, 65, 70, 75, 80, 85 and 90 deg.

Results: Cutting angle of 75 deg. to 80 deg. proved most durable and the durability curve falls off rapidly both above and below this angle. (True cutting angle measured in plane of shaving was about 81 deg.)

B. For medium steel. (Fluid-pressed, left from Manchester tests.)

Constants: Cutting speed = 74 ft. per minute.
Depth of cut = ¼ in.
Traverse = ⅛ in.
Plan angle = 45 deg.

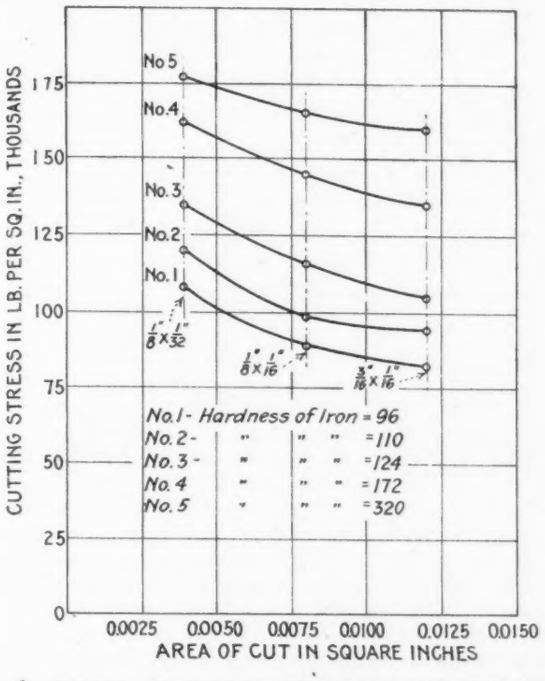


FIG. 2—VALUES OF CUTTING STRESS FOR CAST IRON FROM TESTS MADE AT UNIVERSITY OF ILLINOIS

Variable: Cutting angle = 55, 60, 65, 70 and 75 deg.

Result: Cutting angle of 65 deg. proved most durable.

C. Same as in B, except cutting speed = 73 ft. per minute and cutting angles tested = 60, 65, 70, 75 and 80 deg.

Result: Cutting angle of 75 deg. proved most durable.

7. *Experiments on Soft Steel at "Dead Slow" Speed.*

With a plan angle of 67½ deg., a cutting angle of 55 deg., a cut ⅜ in. by ⅛ in., and a constant cutting speed of 1 ft. in five hours, the force R and its three components F_v, F_s and F_t vary from minimum to maximum values periodically, or in waves, the length of which is about ⅜ in. from crest to crest.

Another experiment with ⅜-in. by ¼-in. cut, 45-deg. plan angle, and 60-deg. cutting angle showed a wavelength for the vertical force of about 0.6 in. at a cutting speed of 1 ft. in four and one-half hours, and the vertical force on tool varied from 8000 lb. minimum to 13,000 lb. maximum value. The force attains a maximum soon after the cutting begins to crack or shear across, and drops to a minimum when the small piece of cutting falls off the forging. At such slow speeds the cutting shears off in separate fragments, whereas at speeds higher than a few feet per minute it forms a continuous curl of considerable rigidity. The fragments in this experiment measured about ¼ in. across the widest part of their surface next the top of the tool in the direction of motion.

Remarks on Nicolson's Experiments

It is believed that the foregoing synopsis is self-explanatory. It may be further mentioned in passing that the angle between the resultant force R and a perpendicular to the upper cutting face of the tool was found to be remarkably constant for all except the keenest tools, being about 39 deg. for cutting angles of 55 deg., 75 deg. and 90 deg. The resultant force R, as here used, means the total resultant of all forces acting upon the point of the cutting tool; it has a diagonally downward direction. While the traversing and surfacing components of this force, both of which are in a horizontal plane, do not affect the useful power consumed at the tool edge, they do materially affect the friction losses, and therefore the efficiency of the machine, and have a direct bearing also on the design of the machine parts. A review of the forces shown in these experiments should serve as a comprehensive introduction to the power formulas and their constants.

Formula for Useful Power

In the application of the general expression $\text{Hp} = \frac{FS}{33{,}000}$ to the problems of metal planers, lathes, etc., the term S is the cutting speed in feet per minute and F is the cutting pressure on the tool point. These two primary factors of the useful power have been analyzed in the chart. The velocity of cutting is known, measured or assumed in the light of the work the machine is expected to perform. The cutting force for a single tool is equal to the sectional area of the cut in square inches multiplied by the cutting stress in pounds per square inch. Then the formula for machine tools becomes

$$\text{Hp} = \frac{SAP}{33{,}000}, \qquad (4)$$

in which S = cutting speed in feet per minute;
A = cross-sectional area of chip in square inches = feed × cut;
P = cutting stress in pounds per square inch.

It has been shown that the cutting stress P has a variable value depending primarily upon the hardness of the material to be cut, but also upon various other factors as indicated in the chart. With these factors in mind, a number of experimental values of P for iron and steel of different grades have been selected and are shown in the following tables, in which are indicated the several conditions prevailing in each case.

Constants for Cast Iron.—The constants for cast iron are taken from two sources. Those of Table I are average values for medium-hard cast iron, deduced from the Nicolson experiments, while the curves of Fig. 2 are taken from results obtained by Breckenridge and Dirks at the University of Illinois Engineering Experiment Station.[2]

The results of Breckenridge and Dirks are given in Fig. 2 by a separate curve for each quality of iron, and the relative degree of hardness is shown in each case, referred to a standard test piece of soft cast iron of uniform density whose hardness was arbitrarily assumed as 100. The standard test piece showed the fol-

[2] "Tests of High-Speed Tool Steels on Cast Iron," by Prof. L. P. Breckenridge and Henry B. Dirks, Bulletin No. 2, University of Illinois Engineering Experiment Station, 1905. The method employed in these tests neglects the losses in the feed mechanism due to force transmitted through the cutting tool. The cutting stress was calculated from electric-motor power measurements.

lowing chemical analysis: Combined carbon, 0.147 per cent; graphite, 5.03 per cent; silicon, 2.35 per cent; manganese, 0.33 per cent; sulphur, 0.07 per cent; phosphorus, 1.06 per cent. The comparative hardness of the various grades of iron used in the experiments was determined by a series of drill tests, the details of which are given in the bulletin of the experiment station. The cutting tools were round-nosed tools made of ½-in. by 1-in. stock and ground with 12½-deg. front clearance, 10-deg. top rake and 10-deg. side rake. It will be observed that these curves show the cutting stress to decrease with increased area of cut.

Constants for Steel.—Average values of P for soft steel for different cutting angles have been deduced from the Nicolson tests as shown in Table II.

TABLE V—FURTHER VALUES OF THE CONSTANT C

Value of C			Authority	Remarks
Cast Iron*	Wrought Iron*	Steel*		
0.025	0.032	.....	Hartig.....	Results of twenty-three experiments, of which heaviest work was 11.55 lb. of wrought iron per hour at a speed of 24.6 ft. per minute. Cut, 0.08 in.; feed, 0.017 in.
0.030	0.027	0.045	Hartig.....	Results of forty-one experiments. Heaviest work on wrought iron was 25 lb. per hour (on 17½-in. lathe) at 15.88 ft. per minute. Cut, 0.04 in.; feed, 0.20 in.
0.040	.....	.....	Hartig.....	26-in. lathe. 10.93 lb. of cast iron per hour at 32 ft. per minute. Cut, 0.024 in.; feed, 0.08 in. Result of ten measurements.
0.028	0.045	.....	Hartig.....	Another set of readings.
0.025	.....	.....	J. F. Hobart..	Side tool. 13.3 lb. of metal per hour at 37.9 ft. per minute. Tests on 20-in. Fitchburg lathe.
0.020	.....	.....	J. F. Hobart..	Diamond tool. 10.7 lb. per hour at 30.5 ft. per minute. Same lathe.
0.023	.....	.....	J. F. Hobart..	Round-nosed tool. 14.95 lb. per hour at 42.6 ft. per minute. Same lathe.
0.026	.....	.....	J. F. Hobart..	Left-hand round-nosed tool. 9.22 lb. per hour at 26.29 ft. per minute. Same lathe.
0.028	.....	.....	J. F. Hobart..	Square-faced tool, ¼-in. broad. 9.06 lb. per hour at 25.82 ft. per minute. Same lathe.
0.018	.....	.....	J. F. Hobart..	Square-faced tool, ¼-in. broad. 10.89 lb. per hour at 25.27 ft. per minute. Same lathe.
0.023	0.028	0.042	R. H. Smith..	Average values from experiments conducted on a 29-in. lathe, in England.
0.026	0.030	0.044	.....	Average for above investigators.

*Grade not stated.

Hartig's Formula

It is obvious that the product of the two terms S and A of equation (4) is equal to the volume of metal removed per minute, and this is proportional to the weight of metal removed per unit of time. The weight of metal removed per hour, which will be called W, may therefore be substituted for the quantity SA in equation (4), provided a suitable constant C is introduced. The cutting stress P may be regarded as constant for any given material and under any given set of conditions, and it may therefore be included in the constant C, as may also the numeric 33,000 of the previous formula. Equation (4) will then become

$$\text{Hp} = CW \qquad (5)$$

in which C = a constant;

W = weight of metal removed per hour.

In this form the power equation is known as Hartig's formula. It has been in use for a number of years. In some cases this may be the most convenient form, and a number of experimental values of the constant C are therefore given. If the weight of medium-hard cast iron is taken at 0.2604 lb. per cubic inch, and the weight of soft steel at 0.285 lb. per cubic inch, the figures of Tables I and II reduce to those of Tables III and IV.

Table V gives a number of values of C deduced by Dr. Hartig and others from experiments with ordinary tempered tool steels. The values of 0.035 for thirty-point carbon steel and 0.034 for hard cast iron also have been proposed by other writers, the latter figure having been determined by experiments carried out at the Trigg works of Richmond, Va.

With the value 0.034 of the constant for cast iron the formula reduces approximately to the following very convenient form for hasty preliminary estimates:

$$\text{Hp} = 7fds \qquad (6)$$

TABLE VI—FRICTION LOSSES IN A 9-IN. LATHE WITH BELTS AND COUNTERSHAFT, FROM TESTS BY BRECKENRIDGE & DIRKS

Load (Useful Power), Hp	Friction Loss in Hp		Efficiency of Transmission in per Cent	
	Back Gears In	Back Gears Out	Gears In	Gears Out
0.5	0.50	0.41	50	55
1.0	0.62	0.50	61.7	66.6
2.0	0.75	0.63	72.7	76
3.0	0.90	0.75	76.9	80
4.0	0.98	0.83	80.3	82.8

NOTE.—Feed-mechanism losses due to force on cutting tool are here neglected.

TABLE VII—POWER REQUIRED TO DRIVE EMPTY LATHES

13½-in. Lathe, Zimmermann, New Machine			17½-in. Lathe, Zimmermann, New Machine			20-in. Lathe, Fitchburg			26-in. Lathe, Zimmermann		
Back Gears	R.P.M. of Spindle	Hp	Back Gears	R.P.M. of Spindle	Hp	Back Gears	R.P.M. of Spindle	Hp	Back Gears	R.P.M. of Spindle	Hp
In	4.84	0.132	In	6.61	0.157	In	8.34	.....	In	2.31	0.035
In	8.18	0.150	In	9.95	0.177	In	14.6	0.126	In	4.12	0.047
In	12.8	0.187	In	14.8	0.206	In	24.33	0.141	In	6.72	0.063
In	19.2	0.230	In	22.1	0.249	In	38.42	0.274	In	10.8	0.087
Out	47.4	0.159	Out	53.6	0.206	Out	81.11	0.126	Out	18.8	0.086
Out	80.4	0.202	Out	82.2	0.260	Out	132.72	0.145	Out	33.5	0.137
Out	125.0	0.259	Out	122.0	0.339	Out	219.08	0.197	Out	54.6	0.210
Out	188.0	0.339	Out	183.0	0.455	Out	365.00	0.310	Out	82.2	0.326

in which f = feed in inches per minute;

d = depth of cut in inches;

s = velocity of cutting in feet per minute.

Drilling machines offer certain exceptions to the rule in that the depth of hole is a factor. An increase of

depth increases the friction of the drill, owing to its clogging with chips. The diameter of the drill is also to be taken into account, as a large drill requires less power per pound of metal removed than a small one, owing to the greater drawing-in action of the larger drill which relieves a certain amount of the pressure on the spindle and feed mechanism.[1]

through a 4-in. single belt to the motor pulley, about 9 in. in diameter. The friction losses and efficiency of transmission recorded in the table therefore have reference to the total transmission from motor pulley to cutting tool.

The figures of Table VII are taken from the results of Hartig and others, to show the power required to

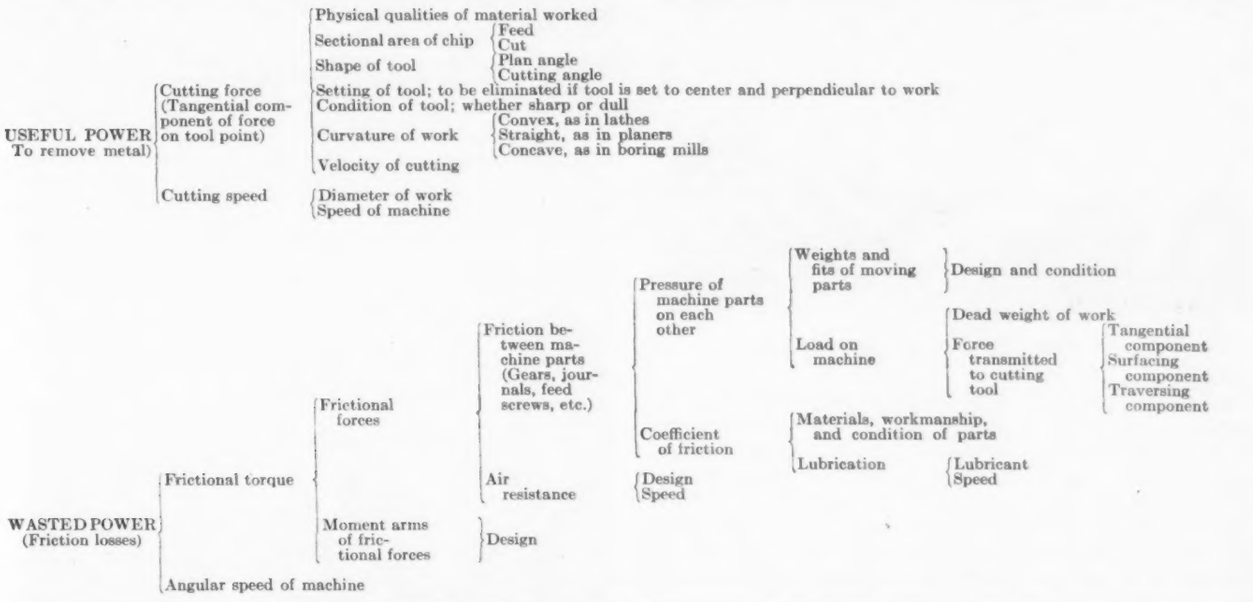


CHART SHOWING ANALYSIS OF POWER DELIVERED TO MACHINE TOOL

Efficiency of Machine Tools.—The ratio of the useful power to the total power input may be termed the efficiency of the machine tool, or

$$\text{Efficiency} = \frac{\text{Useful power}}{\text{Useful power} + \text{wasted power}}.$$

The efficiency will be different for different pieces of work and will vary with changing load, with changes of gears, and with varying speeds, since the friction losses are affected by all these factors. It is therefore a very indefinite quantity. New machines frequently require excessive power when first put in operation, because of stiff parts. Tight belts will increase the friction losses considerably and hard-set dead centers, especially if allowed to run dry, may more than double the power losses. It is probable that, as a rough estimate for full-load average conditions, 80 or 85 per cent would be a fair figure for machine-tool efficiency. Due allowance for the wasted power must, of course, be made in selecting a driving motor. As a further guide in this direction the data of Tables VI and VII may be of some assistance.

Table VI is adapted from the University of Illinois experiments previously referred to. It shows the variation with load of the power consumed in friction by a 9-in. lathe with its countershaft and belts, the speed being constant. The useful power for this test was absorbed and measured by a Prony brake applied to the revolving work between the lathe centers. The machine was a Pratt & Whitney high-speed lathe of modern design with geared-type headstock. It had a swing, over the carriage, of 9 in. and a length between centers of 3 ft. 9 in. The lathe pulley was belted through a 4-in. double belt to a 12-in. pulley on the countershaft, which carried another pulley 37 in. in diameter, belted

[1] See article by L. P. Breckenridge, *Journal of Engineering Society, Lehigh University*, 1888.

drive empty lathes of several sizes at various spindle speeds, both with back gears in and with back gears out. These were belted-type lathes with cone-pulley drives.

Cost of Reading and Maintaining Steam-Heating Meters

BY H. A. WOODWORTH

On the steam-heating mains of the Merchants' Heat & Light Company at Indianapolis, Ind., there are approximately 500 customers and the total radiation served is about 1,200,000 sq. ft. Although the company has some flat-rate customers, most of the others are served

SUBDIVISION OF METER DEPARTMENT COSTS

Item	Cent per Square Foot of Radiation	Cent per 1000 Lb. of Condensation
Cost per season for meter reading	0.020	0.028
Cost per season for repairs	1.162	0.270
Cost per season for testing	0.024	0.030
Cost per season for departmental expenses	0.170	0.200
Cost per season chargeable to meters	0.376	0.528

on a meter basis and the records kept show that the cost of operating the meter department is 0.376 cent per sq. ft. of radiation per year, or 0.528 cent per 1000 lb. of condensation.

The manner in which the various expenses of the department were subdivided is shown by the accompanying table.

Motor-Driven Drag-Line Excavators for Constructing Headwater Diversion Channel

Motor-driven drag-line excavators will be employed in constructing a 30-mile diversion channel in the Little River Drainage District in Missouri for protecting about 500,000 acres of land now subject to floods. These machines are notable for their size, rapidity of opera-

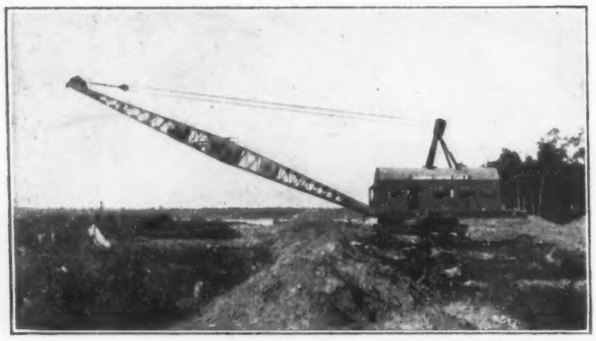


FIG. 1—DROPPING BUCKET BEFORE DRAG

tion, special turntable construction, telescopic current-transmission joint, improved application and arrangement of electric and compressed-air controlling devices, and for their self track-laying facilities. Under favorable conditions each excavator is expected to handle 2000 cu. yd. of earth in one ten-hour shift, depositing it in final position in a spoil bank 18 ft. high and 40 ft. beyond the berm on which the machine will travel.

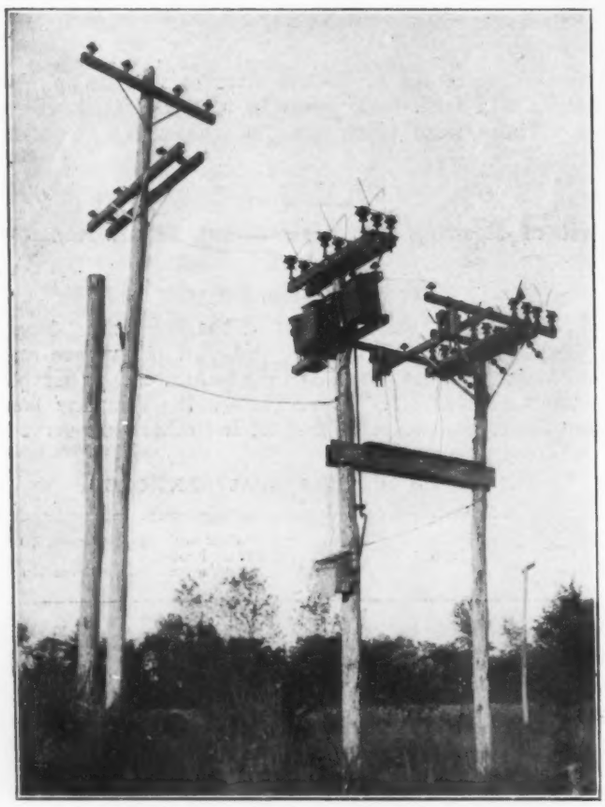


FIG. 2—SWITCHES, FUSES, LIGHTNING ARRESTERS AND METER AT POINT WHERE CONTRACTORS' LINE BRANCHES

Each excavator together with its operating machinery is installed on a heavy steel platform mounted on a 24-ft. turret-type turntable which can be revolved through a complete circle by a rack-and-pinion swinging gear. The turntable in turn is supported on four four-wheel trucks running on seven sets of 15-ft. track section. When the machine is to be moved the track sections can be rapidly picked up in the rear by the boom, swung 180 deg., and placed in front ready for the machine to advance. For this operation hooks are connected to the scraper bucket.

The 4-yd. scraper-type Page bucket which is employed is handled by a 1.25-in. Hercules cable which with the nine-part boom topping lift is operated by a Lidgerwood special elevator engine driven by a 225-hp General Electric motor. The boom can be arranged to operate a clam-shell or an orange-peel bucket by adding another sheave at the end.

The brakes for the swinging engine and bucket hoist are operated by compressed air furnished by a 15-hp motor-driven compressor. The swinging gear is operated by a 112-hp motor. Magnetic master switches control the operations of the bucket and swinging

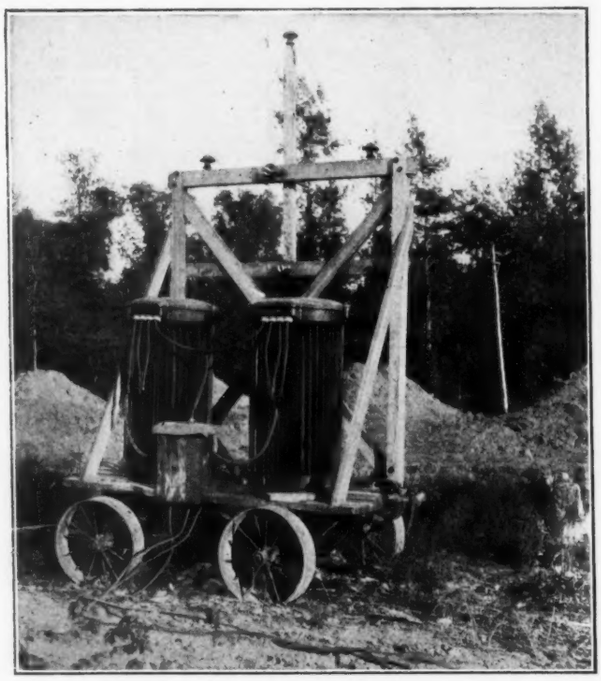


FIG. 3—TRANSFORMER TRUCK, HIGH-TENSION LINE IN BACKGROUND

motors. The weight of the boom and loaded bucket is counterbalanced by 20 cu. yd. of concrete placed on the machine platform where it serves as a floor. Each machine is provided with a 15,000-cp electric lamp which will furnish sufficient illumination within the working radius of the excavator to enable work to be carried on at night.

High-voltage three-phase, sixty-cycle energy will be furnished by the Missouri Utility Company through an auxiliary transmission line which will be extended along the right-of-way as the work progresses. Before this energy is delivered to the excavator the pressure will be stepped down to 440 volts by a transformer carried independently of the machine on a small truck connected to it by 400 ft. of flexible cable. This arrangement permits of moving the excavator 800 ft. before the transformer connections are changed. Energy is conveyed from the transformers to the body of the excavator through brush-and-ring contacts mounted on the axis of the turntable.

Each machine is operated by a crew of four men in addition to an electrician. The work is being supervised by Mr. William A. O'Brien, chief engineer of the

Little River Drainage District. The machine described was manufactured by the Lidgerwood Manufacturing Company.

Electric Drive Supplants Steam Engine and Belt Transmission

D. S. Walton & Company, among the largest paper-bag manufacturers in New York City, who have been employing steam-engine drive for about thirty years, have recently been induced to use central-station service. The boilers formerly furnishing all of the steam are being operated at low pressure for steam heating and the engine has been discarded, the space it occupied now being used as a storeroom. Conditions which existed formerly made motor drive particularly desirable. The old prime mover was installed in the basement, and no power was used below the third floor, so that a long belt had to be employed to connect the engine with the shafts on the upper floors. As the equipment had been in use a long time, the countershafts were not in perfect alignment and the friction loss was very high. From indicator cards taken every half hour for a day it was found that the average load was 36 hp and the friction load 15 hp, or about 42 per cent. Other trial tests showed that the speed of the main shaft on the third floor fluctuated badly, sometimes rising to 176 r.p.m., then dropping to 171.5 r.p.m. The shaft on the fourth floor, from which large presses were operated, varied in speed from 168 r.p.m. to 173.5 r.p.m. Operation of the freight elevators, which were driven by separate steam engines, caused large fluctuations in speed by oxertaxing the boilers.

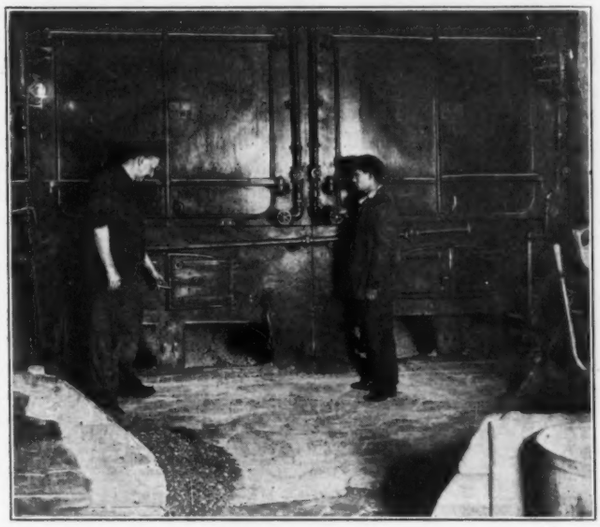


FIG. 1—BOILERS NOW USED FOR HEATING ONLY

The manufacturers were shown that by installing group-drive motors the friction loss could be reduced about 66 per cent, making the average load about 26 hp instead of 36 hp as with steam operation. Aside from this, it was pointed out that production could be increased by maintaining constant speed, that one part of the factory could be operated overtime without running idle equipment in other parts, that electrical equipment would require less attention, permitting the engineer and fireman to be assigned to other duties, that electric-service would be available night and day, that breakdown of one motor would not shut down the whole factory as would non-operation of the steam engine, that fire and explosion risk would be eliminated, that extra space would be available, and that additional machinery could be easily installed by simply adding more motors.

The motor equipment which is indicated in the table as "recommended," was suggested because machines which operate simultaneously should be driven by the same motor. Owing to the initial expense which would be involved, however, slight changes were made by the manufacturer's consulting engineer, who decided to combine the rating of several motors in single units.

MOTOR EQUIPMENT

Floor	Hp of Motor Recommended	Machines Driven	Hp of Motors Installed
6	7.5	Two cylinder presses	10
	5	One cylinder press	
	2	One cutter	
	3	Two paper cutters	3
5	7.5	Four cylinder presses	
		Four job presses	
	5	Six cylinder presses	10
		One job press	
	3	Two cylinder presses	
		One job press	
	0.5	Paste mixer	
	7.5	Four tubing machines	7.5
	3	Three bag machines	
	5	Four bag machines	
4	10	Two web presses	
		One cylinder press	20
		One paper cutter	
	15	Six presses	
	10	Three web presses	
		One slitting machine	
	3	Circular saw	10
		Planer	
		Router	
		Cutter	
3	7.5	Four toilet-paper machines	
		Small paste mixer	7.5
	5	Two paper cutters	
		One punch	
Basement	3	Blade grinder	3.5
		Roof-tank pump	6
		Two freight elevators	26

With the old method of operation 12 tons to 15 tons of coal were burned per week, water had to be purchased for generating steam, and a licensed engineer and firemen had to be employed. Excluding overhead charges, the operating expenses amounted to over $3,200 a year. Now the average monthly energy consumption is about 4000 kw-hr. and the rate approximately 5.5 cents per kw-hr. The output of the factory amounts to about 100,000,000 bags per year, besides various other specialties which can be made in the stereotyping department. Electric service is being furnished by the New York Edison Company. Mr. Henry Floy was consulting engineer for D. S. Walton & Company.

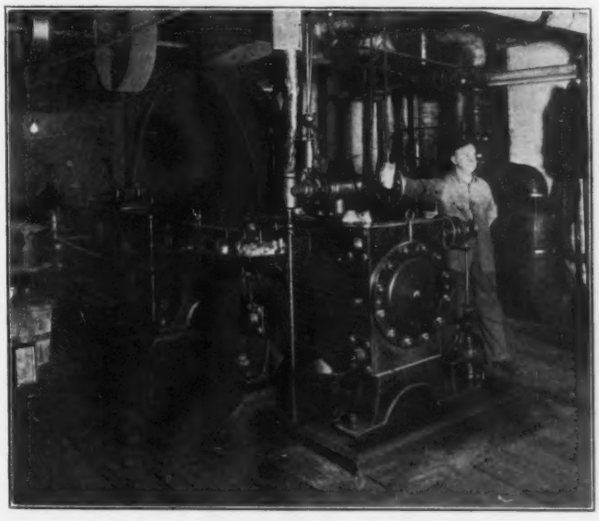
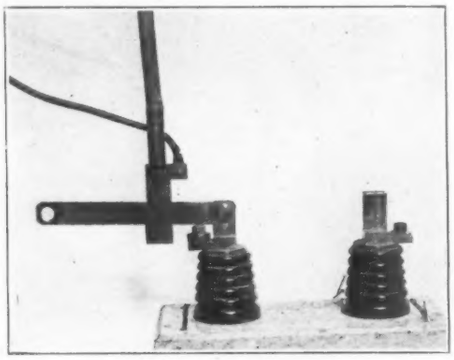


FIG. 2—ENGINE SUPPLANTED BY GROUP MOTOR DRIVE

Operating Kinks

Grounding Device

The accompanying illustration shows the design and application of a grounding device used by the Washington Water Power Company, Spokane, Wash., on circuits up to 13,000 volts. A clip fitted with a lug is made so

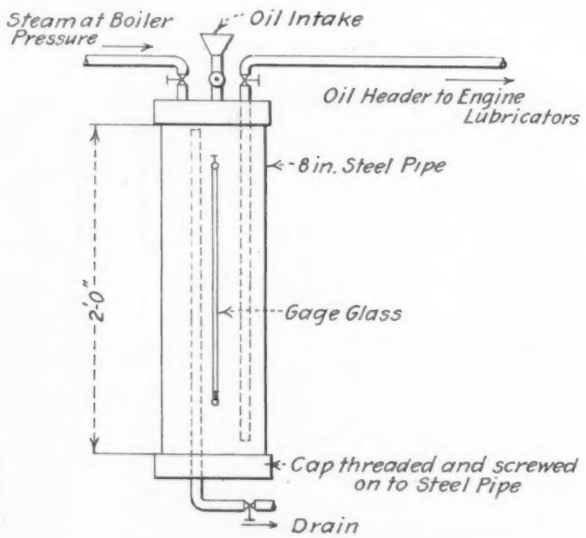


APPARATUS USED IN GROUNDING

that it can be slipped over the blade or into the jaws of a switch. It is attached to the switch by means of a rod about 4 ft. long having a holder on one end which can be hooked into two holes on the end of the clip and then tightened up by turning. When the clip has been attached, the rod is partly unscrewed and taken off.

Steam-Pressure-Operated Graphite Feeder

Mr. H. E. Smith, chief engineer at the Terre Haute (Ind.) power house of the Terre Haute, Indianapolis & Eastern Traction Company, has devised a piece of home-made apparatus for injecting graphite into the station boilers. In brief this graphite feeder consists

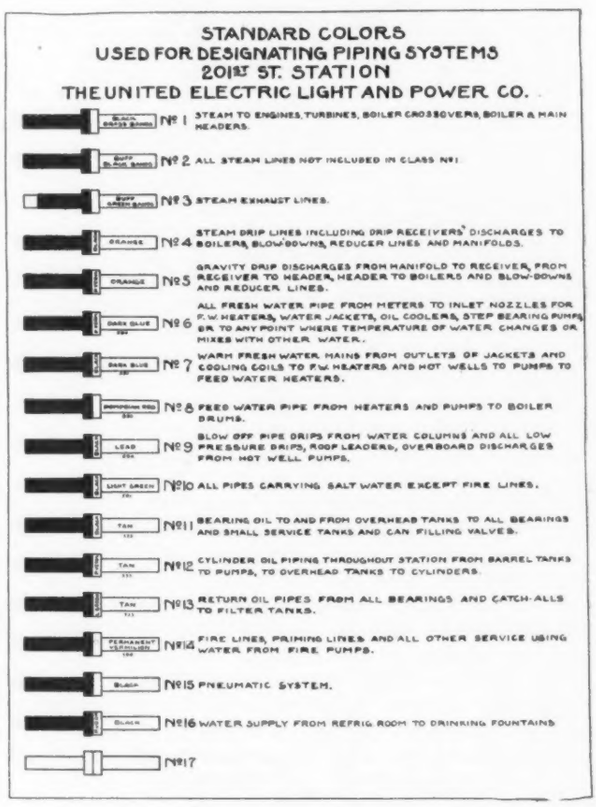


CENTRAL OIL-SUPPLY SYSTEM FOR AUXILIARIES

of a steel cylinder, which is a container for the graphite, and pipe connections to a steam main and to the suction line of the boiler-feed pumps. The graphite is poured into the cylinder through the funnel-shaped intake while the steam valve and the outlet valve are closed. Then, with the cylinder charged, the intake valve is closed and the steam as it is admitted exerts pressure upon the graphite and forces it into the suction line when the hand-operated outlet valve is opened. A check valve in the outlet line prevents water from backing into the cylinder. Speaking of the operation of the device, Mr. Smith said that it is as near fool-proof as it can be made and that the introduction of graphite into the water increases the life of the packing in the boiler-feed pumps and improves the quality of the feed water itself.

Color Scheme for Identifying Pipe Lines

The United Electric Light & Power Company, New York City, has painted all pipes in its new 201st Street generating station with symbolic colors which are interpreted by charts posted in conspicuous places. One of the charts is reproduced herewith. On the original chart the pipe sections are shown in symbolic colors. For instance, steam mains, boiler crossovers, boiler and main headers and steam-supply pipes leading to prime movers are painted black and bound with brass bands; all other steam-supply lines are painted buff and wrapped with black bands; pipes carrying exhaust steam are painted buff and wrapped with green bands; steam drip lines, including drip receivers' discharges to boiler blow-downs and reducer lines leading to manifolds, are colored orange and the flanges painted black. Gravity-drip discharges from manifolds to receiver and from receiver to headers, boilers, blow-downs and reducer lines


STANDARD COLORS
USED FOR DESIGNATING PIPING SYSTEMS
201ST ST. STATION
THE UNITED ELECTRIC LIGHT AND POWER CO.
No 1 STEAM TO ENGINES, TURBINES, BOILER CROSSOVERS, BOILER & MAIN HEADERS.
No 2 ALL STEAM LINES NOT INCLUDED IN CLASS No 1
No 3 STEAM EXHAUST LINES.
No 4 STEAM DRIP LINES INCLUDING DRIP RECEIVERS' DISCHARGES TO BOILERS, BLOW-DOWNS, REDUCER LINES AND MANIFOLDS.
No 5 GRAVITY DRIP DISCHARGES FROM MANIFOLD TO RECEIVER, FROM RECEIVER TO HEADER, HEADER TO BOILERS AND BLOW-DOWNS AND REDUCER LINES.
No 6 ALL FRESH WATER PIPE FROM METERS TO INLET NOZZLES FOR F. W. HEATERS, WATER JACKETS, OIL COOLERS, STEP BEARING PUMPS, OR TO ANY POINT WHERE TEMPERATURE OF WATER CHANGES OR MIXES WITH OTHER WATER.
No 7 WARM FRESH WATER MAINS FROM OUTLETS OF JACKETS AND COOLING COILS TO F.W. HEATERS AND HOT WELLS TO PUMPS TO FEED WATER HEATERS.
No 8 FEED WATER PIPE FROM HEATERS AND PUMPS TO BOILER DRUMS.
No 9 BLOW OFF PIPE DRIPS FROM WATER COLUMNS AND ALL LOW PRESSURE DRIPS, ROOF LEADERS, OVERBOARD DISCHARGES FROM HOT WELL PUMPS.
No 10 ALL PIPES CARRYING SALT WATER EXCEPT FIRE LINES.
No 11 BEARING OIL TO AND FROM OVERHEAD TANKS TO ALL BEARINGS AND SMALL SERVICE TANKS AND CAN FILLING VALVES.
No 12 CYLINDER OIL PIPING THROUGHOUT STATION FROM BARREL TANKS TO PUMPS, TO OVERHEAD TANKS TO CYLINDERS.
No 13 RETURN OIL PIPES FROM ALL BEARINGS AND CATCH-ALLS TO FILTER TANKS.
No 14 FIRE LINES, PRIMING LINES AND ALL OTHER SERVICE USING WATER FROM FIRE PUMPS.
No 15 PNEUMATIC SYSTEM.
No 16 WATER SUPPLY FROM REFRIG. ROOM TO DRINKING FOUNTAINS
No 17

PIPE COLOR CHART

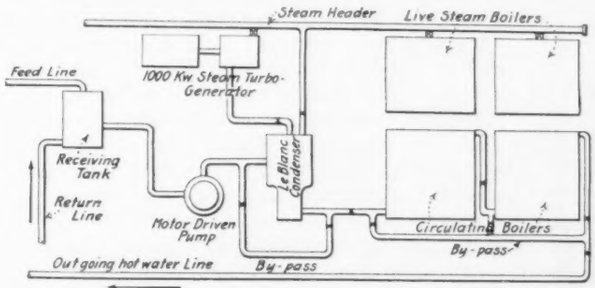
are also painted orange but are provided with permanent vermilion flanges. Pipes carrying fresh water from meters to any point where the temperature of the water is changed or mixed with other water are painted blue with permanent vermilion flanges; mains carrying warm fresh water from outlets of jackets and cooling coils to feed-water heaters are also painted blue but are

provided with black flanges; feed water from heaters to boiler drums is conveyed through pipes painted Pompeiian red; lead-colored pipe with black flanges is connected to blow-off pipes, drips from water columns and all low-pressure drips, roof leaders and overboard discharges from hot-well pumps, etc.; salt water except for fire lines is conveyed through pipe colored light green with black flanges; fire lines and all pipes drawing water from the fire-protection main are painted permanent vermilion. All oil pipes are painted tan, those conveying bearing oil being equipped with black flanges, those conveying cylinder oil being provided with permanent vermilion flanges, and the return-oil pipes being designated by light-green flanges. Pipes used in the pneumatic system are painted black, while lines conveying drinking water are painted black with permanent vermilion flanges.

Flexible Central-Heating System

BY H. A. WOODWORTH

With the rehabilitation of the hot-water central-heating station of the Merchants' Heat & Light Company at Indianapolis, Ind., the water returning from the system of mains enters an ordinary receiving



STANDARD APPARATUS OPERATING A HOT-WATER-HEATING PLANT

tank, from which it is taken by a 125-hp motor-driven centrifugal pump or a 115-hp steam-driven centrifugal pump, and delivered to a standard Le Blanc condenser serving a 1000-kva turbo-generator. In order to make the installation sufficiently flexible to permit arying the electrical load and also varying the outgoing hot-water temperature, a live-steam by-pass line has been connected around the turbine and a water line by-pass has been installed around the condenser. By manipulation of the valves in these pipe lines it is possible for the operators to raise the temperature of the outgoing water quickly by adding live steam, or to lower the temperature by partially by-passing the condenser without seriously affecting the existing electrical operating condition.

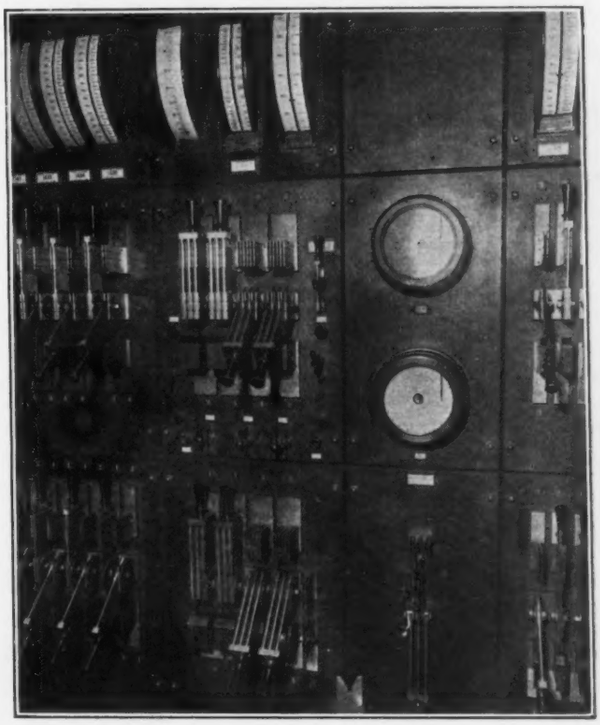
In ordinary Indiana winter weather the return water reaches the condenser jet at from 120 deg. to 170 deg. Fahr., and with this water it is possible to carry a vacuum of from 19 in. to 23 in. on the condenser and to add enough heat to the circulating water to raise its temperature from 10 deg. to 30 deg. Fahr. When the weather is mild one or several of the circulating boilers may be taken out of service. With this system it is generally necessary to remove water from the receiving tank at more or less regular periods instead of replenishing the supply as is usual, because the turbo-generator in operation adds 30,000 lb. of water an hour at full load to the system, which very much more than compensates for occasional leaks.

Since the rehabilitation of the system it has been found that there is a saving in coal and in cost of operation. Besides these economies a further saving is evident because there is very little apparatus to lie idle during the summer months, since the condenser still serves the turbo-generator and the hot-water boilers may be used for steaming. Hence there is a saving in capital invested and in station floor space.

Compact Four-Bus Switching Arrangement

Instead of regulating the voltage at the supply end of its direct-current feeders to allow for line drop during fluctuating loads, the Edison Electric Illuminating Company of Brooklyn maintains a constant pressure at the feeder taps in the network system. To do this it is necessary to provide a multi-voltage supply system. Four sets of positive and negative buses are therefore employed, one pair being permanently connected to the storage-battery system and the other three sets being energized at the voltages which may be required for maintaining the constant feeder-tap pressures.

Each feeder and rotary converter is provided with positive and negative switches, each feeder having two and the rotaries four separably operable blades. The feeder switches are arranged as shown in the accompanying illustration, so that they occupy very little more room than the switches required on a two-bus switchboard. This is made possible by attaching the hinges of the two blades on each switch to a common terminal block. On the feeder panel the two blades swing upward or downward, while on the machine panels the jaws are grouped in pairs and swing in the same manner. With this switching arrangement it is therefore always possible to start a rotary converter from the bus



FOUR-BUS SWITCHBOARD, SHOWING COMPACT ARRANGEMENT OF SWITCHES

connected to the storage battery. Besides this, each converter with its boosting equipment can be employed to maintain the desired voltage on any one of the four busbars. With the four supply pressures available it is not a difficult matter to maintain the proper voltages at the feeder tap-in point.

Extracts and Abstracts

Types of Fractional-Horse-Power Motors to Employ in Different Services

The popularity of fractional-horse-power motors will depend on the ease of starting and stopping them, on their portability, and on their ability to operate without frequent attention, according to a paper entitled "Fractional-Horse-Power Motor Loads," which was presented by Mr. Bernard Lester before the annual meeting of the Cleveland Section of the A. I. E. E.

As single-phase alternating-current distribution is employed to a great extent in the residence district, single-phase motors of series, repulsion or induction type, or combinations thereof, have been largely used. Series-wound single-phase motors can be safely used where the load is rigidly connected to the driving shaft of the motor and where large variations in speed are permissible with variations of load. One great advantage of the series motor is that it can be operated upon either direct current or alternating current. Single-phase repulsion motors, while having the same limitations as series motor as regards speed-torque characteristics, do not attain dangerously high speed without loads. On the other hand, they cannot be operated on direct current. With single-phase induction motors the speed remains practically constant under varying torque, therefore they are especially adapted to driving a large majority of small machines, provided that auxiliary starting equipment is employed. Some single-phase induction motors are started by the split-phase principle which requires the use of an auxiliary resistance and inductance. Improved types of single-phase induction motors contain a small high-resistance starting winding in addition to the running winding. The starting winding is cut out at a speed slightly below full load by a centrifugally operated switch.

By adding extra brushes to the commutator and an auxiliary winding to the primary circuit repulsion motors have been made to run at fairly constant speed and improved power-factor with varying loads. Among qualities which are specially desirable in fractional-horse-power motors are attractiveness of appearance, light weight, compactness and quiet operation.

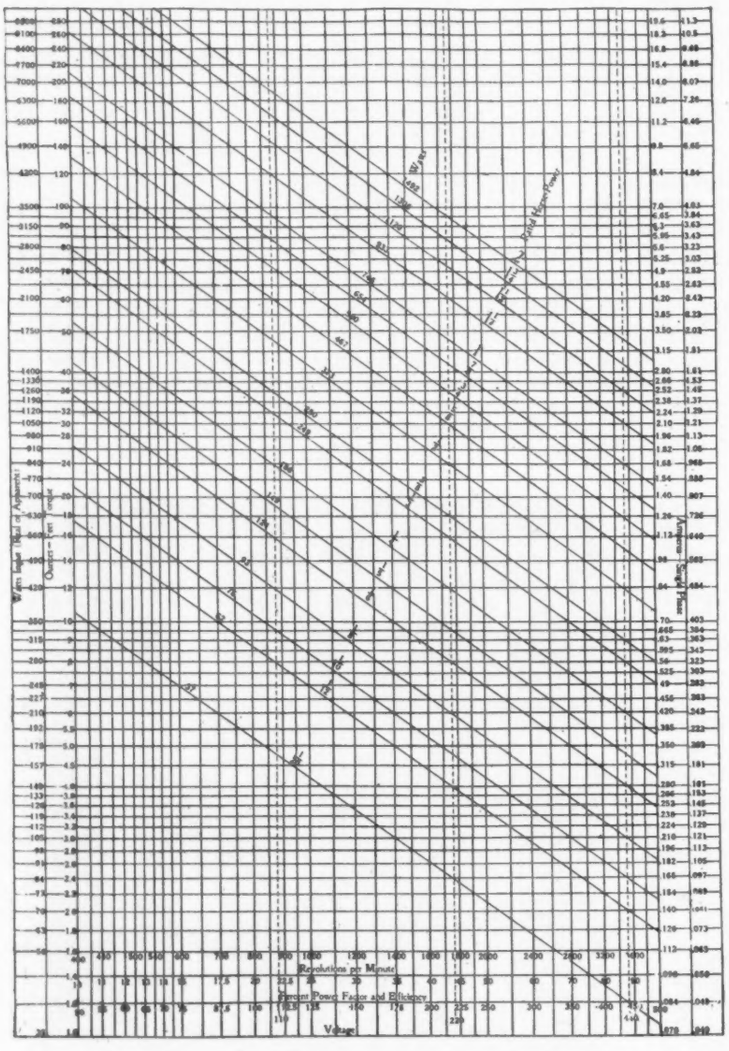


CHART FOR DETERMINING RELATIVE CHARACTERISTICS OF SMALL SINGLE-PHASE INDUCTION MOTORS

It is interesting to note that problems must be solved in fractional-horse-power application almost identical with those in industrial-motor application. Small motors may be divided into four classes, depending on the length of the operating period and the variation of the load: (1) Those operating continuously with approximately constant load-ventilating fans, porch blowers, etc.; (2) those operating continuously with varying loads—sign flashers, adding machines, etc.; (3) machines operating intermittently with constant load—coffee grinders, automatic piano players, etc.; (4) apparatus operating intermittently with varying loads—washing machines, ice-cream freezers, etc. In selecting small motors for any installation, it is advisable to consider the effect which manufacturing in quantities and variations in voltage, frequency, etc., of supply source will have on the electrical and mechanical characteristics. Special attention should be given to the starting torque, pull-out or maximum torque and temperature rating. As the starting torque varies approximately as the square of the impressed voltage, a reduction in the pressure applied to the motor produces more than a proportional reduction in torque. Furthermore, the starting current of the split-phase motor exceeds the full-load running current. If the transformers or wires feeding the motor are small, the starting current may reduce the applied voltage, thereby decreasing the starting torque. Good practice requires that motors be able to start the driven machines when the impressed voltage is 20 per cent below the normal value. If a centrifugal clutch is employed between the motor and the driven machine, it is not necessary to have so high starting torque and the motor will not be subjected to extreme overload in case the machine is suddenly blocked. It was suggested that rules governing the use of single-phase motors on lamp circuits be based on the maximum current which will be required at a definite voltage. It is advisable to emply motors which will develop a torque sufficient to care for peak loads even at voltages lower than the normal rated pressure. When motors are to be used for domestic service or in stores and offices it is not advisable to employ machines so rated that they will attain a temperature as high as the insulation will safely stand as they will create suspicion. The accompanying chart is valuable for determining relative char-

acteristics of small single-phase induction motors. If two-phase motors are being considered, half the current value should be employed when consulting the chart.

Heating Surface a Measure of Steaming Ability

Engineers are rapidly ceasing to rate boilers in horse-power because there is no definite relation between the rating so expressed and the horse-power of the engine which it is capable of driving. Moreover, there is a tendency to force boilers to evaporate more water per square foot of heating surface. For these reasons it is preferable to speak of boilers in terms of their heating surface and not in horse-power rating. In selecting boiler equipment designing engineers usually determine the rate of evaporation which they can expect per unit heating surface with the fuel, draft and setting which is to be employed. The combined water rate of the steam consumers is then computed and divided by the evaporative rate, which has been chosen to obtain the total heating surface of the boilers which will be required.

When manufacturers are asked to bid on boilers they may submit prices on equipment having entirely different dimensions. To enable persons to compare horizontal tubular boilers directly both as to heating surface and horse-power the Hartford Steam Boiler Inspection & Insurance Company has prepared the table herewith.

BOILER HEATING SURFACE AND HORSE-POWER

Diameter of Boiler In.	Tubes			Heating Surface				Horse-Power
	Length, Ft.	Diam., In.	No.	Tubes	Shell	Rear Head	Total	
54	14	3	54	552	99	8	659	66
54	16	3	54	631	113	8	752	75
54	14	3½	44	526	99	8	633	63
54	16	3½	44	601	113	8	722	72
54	14	4	34	467	99	8	574	57
54	16	4	34	534	113	8	655	65
60	16	3	72	841	125	10	976	98
60	18	3	72	946	141	10	1097	110
60	16	3½	50	684	125	10	819	82
60	18	3½	50	770	141	10	921	92
60	16	4	46	722	125	9	856	86
60	18	4	46	812	141	9	962	96
66	16	3	94	1098	138	11	1247	125
66	18	3	94	1235	156	11	1402	140
66	16	3½	70	957	138	11	1106	110
66	18	3½	70	1077	156	11	1244	124
66	16	4	56	878	138	11	1027	103
66	18	4	56	988	156	11	1155	115
72	16	3	118	1378	151	13	1542	154
72	18	3	118	1550	170	13	1733	173
72	20	3	118	1722	189	13	1924	192
72	16	3½	94	1285	161	13	1449	145
72	18	3½	94	1446	170	13	1629	163
72	20	3½	94	1606	189	13	1808	181
72	16	4	70	1098	151	13	1262	126
72	18	4	70	1235	170	13	1418	142
72	20	4	70	1372	189	13	1574	157
78	16	3	140	1635	163	15	1813	181
78	18	3	140	1839	184	15	2038	204
78	20	3	140	2043	204	15	2262	226
78	16	3½	108	1477	163	15	1655	165
78	18	3½	108	1662	184	15	1861	186
78	20	3½	108	1846	204	15	2065	206
78	16	4	88	1380	163	14	1557	156
78	18	4	88	1553	184	14	1751	175
78	20	4	88	1725	204	14	1943	194
84	18	3	172	2260	198	17	2475	247
84	20	3	172	2511	220	17	2748	275
84	18	3½	136	2092	198	17	2307	231
84	20	3½	136	2324	220	17	2561	256
84	18	4	106	1871	198	16	2085	208
84	20	4	106	2078	220	16	2314	231

It is figured on the basis of 10 sq. ft. of heating surface per boiler-hp, the heating surface as calculated including the inside tube area, one-half the area of the cylindrical portion of the shell, and two-thirds of the area of the rear head minus the combined cross-sectional area of the tube.

Questions and Answers

Causes of Corrosion in Steam Condensers

What causes corrosion in steam condensers? A. E. P.

It may be due to the use of impure water, or to galvanic action, or to both.

Origin of Name "Prony Brake"

Where does the Prony brake get its name? T. W. H.

From a French engineer, Baron de Prony, who was the first to use this form of dynamometer.

Fixed Carbon in Coal

What is meant by the fixed carbon in the proximate analysis of coal? B. G.

It is the carbon that is not driven off with the volatile matter in the coal and exists as coke after the volatile matter has been removed. It is called fixed carbon because it cannot be driven off by mere heating.

Steam Space of Return-Tubular Boiler

About what percentage of the volume of a return-tubular boiler is allowed for the steam space M. E. B.

The steam space occupies approximately one-third the net volume of the boiler. By the net volume is meant the total volume of the shell minus the volume of the tubes.

Relative Weights of Air and Water

How much heavier than air is water, volume for volume? P. K.

The weight of air per cubic foot varies greatly according to the pressure to which it is subjected. At a temperature of 62 deg. Fahr. and under atmospheric pressure it weighs 0.076 lb. per cubic foot. Under the same conditions water weighs 62.36 lb. per cubic foot. The ratio of these two weights is 1 to 819.5, so that under the conditions stated water is almost 820 times as heavy as air.

Flywheel Rim Not Strengthened by Increase of Cross-Section

Is it true that a flywheel cannot be made stronger by increasing the cross-sectional area of the rim? If so, why? L. M.

It is true. The force set up during rotation of the wheel, tending to break it into two parts, is directly proportional to the weight of the material in the rim. If the rim section is doubled, therefore, the area to resist the bursting force is doubled, but the weight, and consequently the bursting force, is doubled at the same time. Hence there is no gain of strength by increasing the rim section.

Total Heat of Wet Saturated Steam

How do you find the total heat in a pound of wet steam? O. R. F.

It is necessary to know the pressure of the steam; also the percentage of moisture in it, which may be designated by m. Then the quality of the steam, or the percentage of the mixture that is dry saturated steam, is $1 - m$, and the total heat of a pound of the wet steam is $H = h + L\,(1 - m)$, in which H is the total heat of a pound of the wet steam, h is the heat of the liquid of saturated steam at the pressure of the wet steam, and L is the latent heat of saturated steam at the same pressure. Thus, if steam at a pressure of 150 lb. per sq. in., absolute, contains 3 per cent of moisture, the total heat per pound is $H = 330.2 + 863.2\ \ (1 - 0.03) = 1167.5$ lb.-Fahr. heat units. The values used are taken from the Marks and Davis steam table.

Hard and Soft Patches on Boilers

What is the difference between a hard and a soft patch on a steam boiler? H. E.

The difference lies in the manner in which the patch is put on. A hard patch is held in place by rivets and is in direct contact with the plate. A soft patch is held by means of tap bolts, and a gasket of copper or a coat of red lead is put between the plate and the patch before the bolts are drawn up.

Size of Air Chamber on Pump

Is there any rule for figuring the size of an air chamber for the discharge end of a pump? J. D. J.

From the variation in the sizes of air chambers on pumps of different makes, yet intended for the same conditions of service, it would seem that there is no generally accepted rule for finding the size. Some suggest that the volume of the air chamber be made not less than five times the displacement of one plunger.

Intensity of Illumination for Factories

What intensity of illumination should be allowed on the working surface in factories? D. I.

It is difficult to specify any definite figure for illumination intensity, for the reason that the required density is materially affected by lack of color contrasts. Materials of a dark color require a greater intensity of illumination than those of a lighter hue. An intensity of 2 ft.-candles may be sufficient for certain classes of work, while other classes may require from 3 to 6 ft.-candles. As a general rule, the finer the work and the more rapidly operations are carried on the greater must be the intensity of illumination.

Laying Armored Cable in Frozen Earth

Can any saving be effected by laying armored cable in frozen earth twice; that is, placing it temporarily in the ground first and then after the ground thaws relaying it to a greater depth? A. M. B.

One central-station company during the last winter laid steel-taped cable in frozen earth to a depth of from 4 in. to 6 in. and intends, when better weather arrives, to dig up all of the circuits and replace them at a depth of from 15 in. to 18 in. The engineers of this company claim that it is a great deal cheaper to handle the cable twice in this manner than to lay it in the final position while the earth is frozen to a depth of approximately 2 ft.

No Minimum Voltage for Electrolytic Damage

Is there not a critical potential difference below which electrolysis will not take place? For example, the college textbooks state that for the electrolytic disassociation of water an emf of at least 1.6 volts is required. Reasoning from this, in the case of underground structures is there any reason to fear electrolytic damage where the difference of potential discovered is less than a volt or so? K. N. S.

While it is true that there is a critical disassociation emf for solutions in which the effect of the electrolytic action is to expend electrical energy on the operation, as in the case of the electrolysis of acidulated water and other familiar electrolytes, it is also a fact that for reactions which in taking place give out energy almost any emf—even a very small fraction of a volt—will hasten the "down-hill" process and thus cause serious "electrolytic" damage. An example of such a "down-hill" reaction is the oxidization of underground structures, and here a very minute potential difference will cause electrolytic damage, as has been shown in numerous cases. On the other hand, it is equally true, as the inquirer points out, that for "up-hill" reactions like the electrolysis of water, an operation which absorbs considerable energy, there is a critical emf required—about 1.6 volts and depending on the electrodes and solution—below which electrolytic disassociation will not take place.

Peripheral Speed of Commutator of Rotary Converter

How may the peripheral speed of the commutator of a commutating-pole rotary converter be ascertained? C. C. S.

The peripheral speed of the commutator face of a commutating-pole rotary converter in feet per minute is equal to the distance in feet between two adjacent neutral points times the frequency in alternations per minute. Thus, in a twenty-five-cycle machine (3000 alternations per minute), if adjacent neutral points are 12 in. apart, the peripheral speed will be 3000 ft. per minute. With sixty-cycle machines (7200 alternations per minute), with 8 in. between adjacent neutral points, the peripheral speed will be 4800 ft. per minute. The above relation of commutator speed to frequency holds true regardless of the number of poles.

Finding Leaks in Surface Condenser

How can leaks in a surface condenser be detected? L. L. U.

If the leak is large, the water that flows through from the water side to the steam side will be of considerable amount and will be indicated by an increased air-pump discharge; but it cannot be detected in this way when the leak is small. It then becomes necessary to remove the end covers, close the valve between the engine and the condenser, and fill the shell of the condenser with water under a pressure of about 10 lb. per sq. in. The water will then be forced through any leaky tubes, and these will be easily discovered since the ends of the tubes are exposed. It is possible that a tube may be split and that the water pressure will close it sufficiently to prevent leakage in making the foregoing test. The vacuum method of testing must then be employed. The shell is freed of water and a partial vacuum is formed in it. A lighted candle is then passed along the ends of the tubes, and wherever a leaky tube exists the rush of the air that is being drawn in will suck the flame sidewise and thus indicate the defective tube. The same test may be used in the case of fittings or joints that are suspected of containing cracks through which leakage may occur.

Exhaust-Steam Regenerator

Can you tell me what an exhaust-steam regenerator is, and where it is used? K. E. N.

The exhaust-steam regenerator is a sort of heat reservoir or accumulator used between a reciprocating steam engine and a low-pressure turbine that is driven by the exhaust steam from the engine. It contains water, which is heated by the incoming exhaust steam, and the heat thus becomes stored up in the water. The turbine withdraws steam at a practically constant rate, but the exhaust from the engine will vary with the load. When the exhaust steam enters more rapidly than it is withdrawn, the excess of heat energy is stored up in the water, increasing the temperature and the pressure in the regenerator. When the exhaust steam enters at a slower rate than the turbine withdraws steam, some of the heat stored in the water evaporates part of the water into steam, and the temperature and pressure in the regenerator fall accordingly. If the rates of inflow and outflow are equal, the temperature and pressure in the regenerator do not change. In this way the regenerator acts as a heat-flow equalizer and enables the exhaust from an engine working under variable load to be used continuously in a turbine.

COMMERCIAL SECTION

THE INFLUENCE OF GOOD-NEIGHBORLINESS

The Public Utility as a Human Institution, with Illustrations from the Right-of-Way of the Commonwealth Edison Company

There is no influence of greater benefit to any public service company than its reputation as a human institution. Just as soon as the impersonal, the purely corporate, side of the central station becomes its most conspicuous characteristic, the sympathy of the men and women who constitute the public begins to fail. But let the human feature of the enterprise stand out most clearly to the public eye and invariably a bond of fellow feeling is established, and every central station can invoke this influence if it will.

It is only natural when a corporation of reputed wealth and power apparently gives up its entire thought and purpose to administering a system of commercial exploitation to which the people all pay tribute that the public should subconsciously rebel and that antagonistic sentiment should breed and grow. But if the visible character of that corporation is distinguished most by human qualities, what a difference it does make! If this corporation takes its natural place among the other factors in the life of the community and plays the part of a good neighbor, how soon the public recognizes and approves!

An interesting illustration of consistent effort by a central station to develop this same feature of good-neighborliness is recorded in a very handsome brochure recently distributed among the residence property holders of Chicago by the Commonwealth Edison Company. The accompanying typical pictures are reproduced from a large number of photographic views of scenes about the stations of the company and along its right-of-way. The cover of the booklet bears the title "Modern Industry Appreciates the Beautiful—and Therefore Strives to Conserve It." Its purpose is described in the preface in these words:

"This brochure is presented for the purpose of obtaining your consideration and proper understanding of the facilities we use for the transportation of our product to you. Locomotives, horses, automobiles or other pavement-destroying and noisy vehicles have no place in this final distribution. Wires are our only medium.

"The illustrations are thought to be of interest to you in that they show the study we give our own properties from an esthetic standpoint, thus manifesting proper appreciation of neatness and beauty in the general scheme of things. . . .

"Only a decade ago," it continues, "upon many streets in Chicago there were much in evidence lines of poles along parkways. In some localities they were set not only upon one side, but upon both sides, of the street. In other instances there were even three lines of poles. Not very decorative to a street, certainly; but progress makes its demands, and at that time those offending poles were very necessary for territories desiring electric light and other electrical facilities.

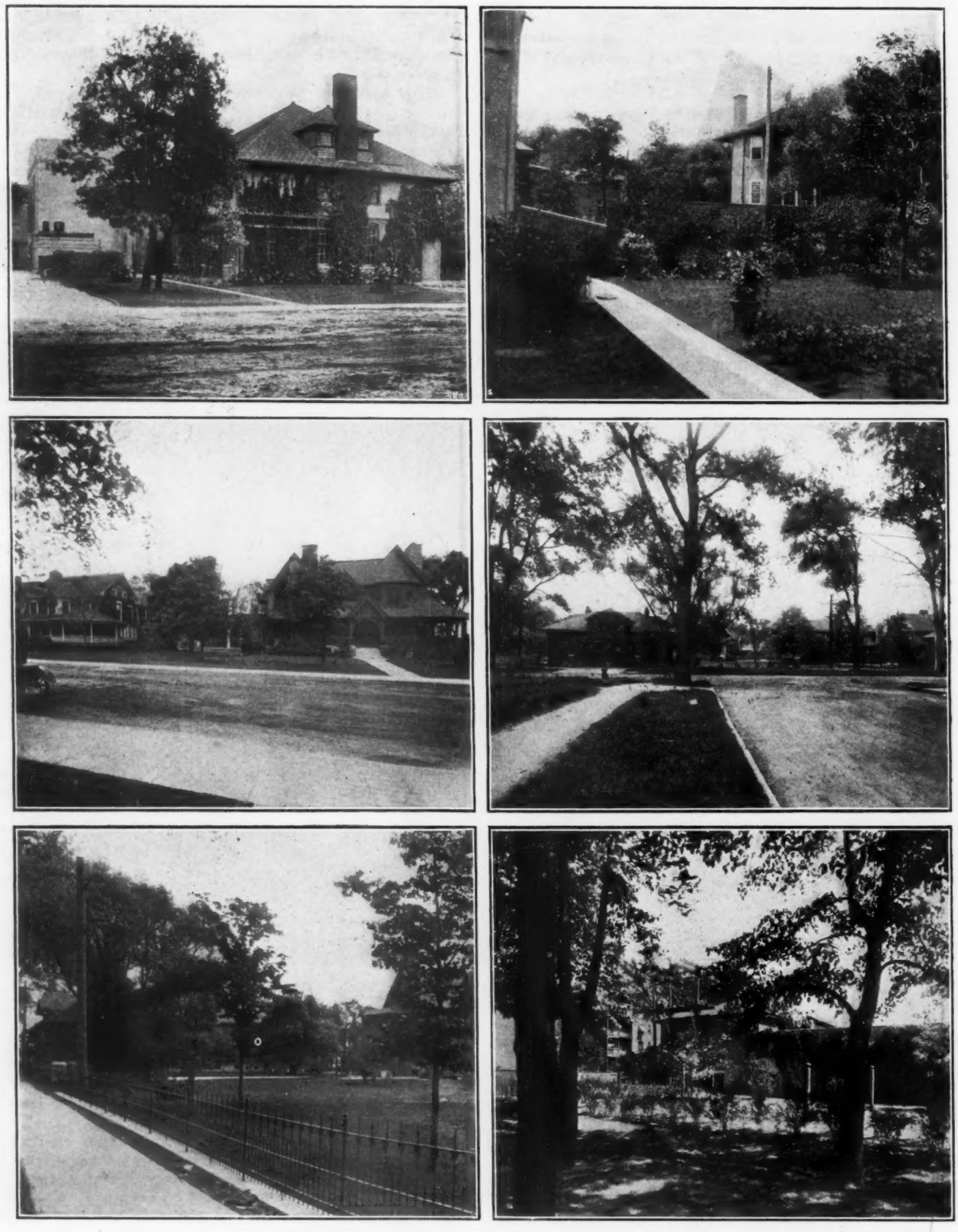
FIG. 1—THE BEAUTIFIED SURROUNDINGS OF THE COMMONWEALTH EDISON COMPANY'S NORTHWEST STATION

"Have you ever noticed that about 80 per cent of these poles have disappeared from the parkways—that the streets are no longer crossed overhead by a network of wires? Have you ever paused to consider by what means this improved condition has been accomplished, while at the same time an enormous increase of facilities has been supplied to meet the ever-growing needs?

"Not alone money, but the patience and labor of our employees, together with your co-operation and a little

of your time and generosity, will produce very definite, beneficial results for your neighborhood by aiding in the removing of the poles from your streets and placing them where they are least objectionable, while at the same time they retain unimpaired efficiency. . . . .

"Remember, we cannot do it all. Neither can you, but you can help, or, at least, not hinder. Also, please remember that any concession you may bring yourself



FIGS. 2 TO 7—EXAMPLES OF NEIGHBORLY TREATMENT OF THE RIGHT-OF-WAY IN CHICAGO

Reading from left to right and from top to bottom: The Ardmore substation with vines, flowers and shrubbery characteristic of the community; an unobtrusive service pole; a front and two rear views of two suburban homes, served from the rear; and a simple service structure which made possible the removal of an obnoxious gas engine.

to make will react beneficially by increased value to your property through improvement to the community."

The explanation and the pictures are assuring testimonial of the fact that in Chicago the central station is striving to be a good neighbor.

Another story comes to mind and brings another interesting example of the helpful influence of the softening touch of beauty. Down in Tucson, Ariz., not so long ago, a lawsuit was decided by some morning-glory vines that grew upon the gas holder.

A citizen, it seems, became convinced that the shade trees and flower gardens of the residence district were being damaged by the close proximity of the gas works. He argued that escaping gas was poisoning the atmosphere and succeeded in alarming other dwellers in the neighborhood until a lawsuit actually was instituted to enjoin the company from permitting gas to escape into the air. But the manager of the gas works had conceived a plan to demonstrate the company's innocence.

No sooner had the misapprehension been discovered than men were set to work to plant a double row of morning glories all around the holder, and in the Tucson climate the growth came fast, until a luxuriant display of vine and flower established such a weight of evidence against the plaintiff that the case was discontinued. But, best of all, the entire community was thoroughly reassured and interested. So Manager F. E. Russell of the Tucson Gas, Electric Light & Power Company sought to take advantage of the situation and proceeded further to beautify the grounds and buildings by planting grass and flowers and shrubbery about the stations. To-day the company's property is actually a show place, and the citizens of Tucson have a very kindly feeling for the men who maintain such a thing of beauty in their city.

The principle is everywhere the same. The opportunity stands awaiting every central station that is eager for a better public sentiment. Let it demonstrate the spirit of good-neighborliness by the natural beautification of the station and the right-of-way. Unnecessarily obtrusive pole lines, uninviting expanses of bare cinder yard, and offensive junk piles and dump heaps have never won a friend for any company. But lawns and flower beds and vines and eager effort to protect your neighbors' property and peace of mind, by making all your system just as inconspicuous as possible—these are things that do make friends. Money invested here pays dividends in a sympathetic public interest and appreciation.

Central-Station Ice-Making

The advantages of the absorption system of ice-making for central stations were pointed out in an address delivered March 19 before the Chicago Section of the American Society of Mechanical Engineers by Mr. Heywood Cochrane, of the Carbondale Machine Company. In one such combination plant cited by the speaker ice is made at a total operating cost of about 40 cents per ton. Of this cost, 11 cents is for fuel, 13 cents for wages, 4 cents for water, and the remainder is charged to meet overhead. Mr. Cochrane emphasized the fact that an absorption system may be operated with circulating water of comparatively high temperature.

Mr. E. W. Lloyd, general contract agent of the Commonwealth Edison Company, recited the growth of the ice-making load of his company from one to eighteen customers' plants in three years. Nearly a third of a million tons of ice are now made annually in Chicago by central-station energy, an output representing about one-tenth of the city's total requirements. The connected ice-making load is now 7000 hp. Most of the Chicago plants employ the raw-water system. Energy is sold for ice-making at an average price of 1 cent per kw-hr. The expected annual load-factor of these ice factories, said Mr. Lloyd, has not wholly materialized, except in the cases of certain plants in special districts. At the outset it was believed that the average annual load-factor of the ice-factory business would be about 65 per cent, but actual results have shown that this load-factor does not exceed 45 per cent except in special instances.

Chairman S. G. Neiler and Messrs. Otto Luhr, F. Wittenmeier and Gardner Voorhees spoke on refrigeration topics.

Energy for Domestic Science at 3 Cents per Lesson per Pupil

Nine electric ranges, eight of which are of the individual two-plate type, have been installed in a new high-school building at Poplar Bluff, Mo. To make the electrical installation economical, flexible and convenient, four ovens have been provided for the eight individual stoves. The ninth stove, a four-plate range with a high 18-in. by 18-in. oven, is fully equipped. The general arrangement of the stoves and worktable are shown in the accompanying photograph.

In this school four classes of sixteen girls each are instructed in cooking twice a week by Miss Winifred McCoy. With the present number of pupils about 512 individual lessons are given each month, and the average monthly energy consumption of the ranges has been 382 kw-hr. Energy as purchased from the Missouri Public Utilities Company for cooking costs the school 4 cents per kw-hr., making the monthly bill about $15, or about 3 cents per lesson per pupil. These ranges, which were made by the Hughes Electric Heating Company, were installed under the direction of Mr. F. M. Wilkes, local manager of the electric-service company.

ELECTRIC COOKING SCHOOL AT POPLAR BLUFFS, MO.

Operating Thresher from Transmission Line

On the same poles with a 33,000-volt transmission line running through the rural districts of Blue Grass, Walcott, Stockton and Durant, Ia., has been installed a 2200-volt primary circuit from which the farmers operate their electrical equipment. As considerable trouble has been experienced in operating a steam threshing machine, the farmers in this district banded together and purchased a portable electric set, including a 2200/220-volt transformer, switches and a 30-hp, sixty-cycle single-phase motor. With the transformer energized from the 2200-volt line they are now able to do their threshing at a constant rate and without danger

from fire due to sparks or live coals. The equipment is mounted on a steel-frame truck which had formerly been used as a road scraper. Erected on one end of the truck is a temporary ladder pole with a cross-arm which carries the 2200-volt lines leading from the transmission line to the transformer. The outfit cost only $800 as compared with the $1,800 to $2,500 which probably would have had to be invested in a gasoline-engine-driven or steam-engine-driven set. It has been reported that the farmers' league has saved 25 per cent in operating by electricity. Energy is furnished by the Muscatine Lighting Company.

Economical Motor Service in Lumber Mill

The disposal of shavings and sawdust is a serious problem in many woodworking plants, but in the mill of the William H. Wood Lumber Company at Cambridge, Mass., the sale of this by-product pays about 67 per cent of the concern's electricity bill. Energy is supplied to the plant by the Cambridge Electric Light Company, the tools being driven by individual three-phase, 550-volt induction motors of General Electric make. The plant has been in service about four years, the average energy consumption per month being 3380 kw-hr., and the total bill for motor service $125.61 per month, an average of 3.7 cents per kw-hr. The net cost of energy is therefore about $42 per month. The equipment of the plant is given in the accompanying table. The average load is about 21 hp, the plant running eight hours per day and six days per week.

The tools are installed in a frame building about 60 ft. long by 40 ft. wide and are arranged to permit the easy handling of stock to and from the various machines. In general, the motors are connected to the tool shafts by flexible couplings, and the motors are usually mounted on the floor and are inclosed by wooden housings to keep them free from sawdust. The wiring is of the open type, the larger motors being provided with internal resistance in the rotor circuit for starting, while the smaller motors are thrown directly upon the line. Fig. 1 shows a motor-driven band rip-saw with the motor

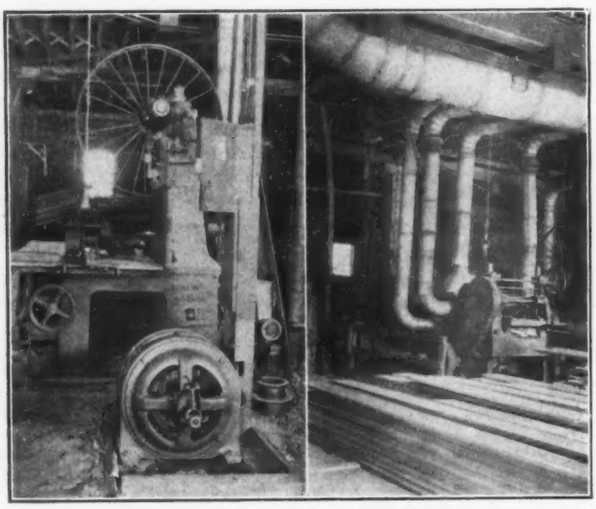


FIG. 1—BAND RIPSAW FIG. 2—EXHAUST DUCTS

housing removed; Fig. 2 shows exhaust ducts for the removal of sawdust and shavings from a four-sided matcher, and Fig. 3 illustrates the use of the baling press, which enables the company to market its sawdust and shavings at an average price of from 15 cents to 20 cents per bale.

The sawdust and shavings are exhausted by the fan from the various machine tools and delivered by the duct system into a separator on the roof, from which either shavings or sawdust may be obtained by gravity and run into the baling press, which performs the function of banding as well as compression. Each bale weighs 80 lb., and the shavings are extensively used in Boston in connection with the bedding of horses, the

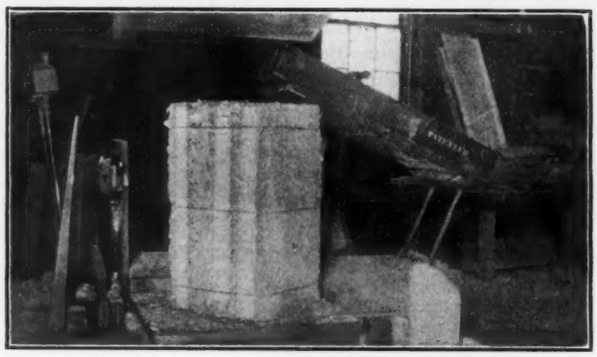


FIG. 3—BALE OF SHAVINGS COMPLETE

lining of walls and floors in refrigerating plants, and other applications. One man can put up from seventy to seventy-five bales per day, the bales being 17 in. by 18 in. by 30 in. in size. In machining 1000 ft. of North Carolina red-heart lumber about ten bales of shavings are produced. The woodworking tools in the plant were all supplied by the Berlin Machine Works of Beloit, Wis., and the press was built by P. K. Dedericks Sons, Albany, N. Y.

EQUIPMENT OF WOODWORKING PLANT

Machine Tool	Rating, Maximum Piece	Motor Hp	Motor R.p.m.
One 6-in. Berlin band resaw	12 in. x 24 in.	35	600
No. 177 Berlin double surfacer	12 in. x 30 in.	35	900
No. 281 Berlin band rip-saw	10 in. x 18 in.	15	720
No. 94 four-sided matcher, Berlin	6 in. x 13 in.	50	1200
One Towsley 18-in. swing-saw and one Dedericks baling press, group-driven by overhead motor	.....	10	1800
One 6-ft. Sturtevant blower, 610 r.p.m., belted	.....	35	1200
Total connected load		180	

Typewriter Electric Sign with 2400 Keys

A large "talking" sign recently installed on a Dearborn Street roof in Chicago has sixty letter spaces the changes of which are controlled by 2400 keys mounted in an operating room 20 ft. long. The letters are set up by depression of these keys, and then a master switch energizes the circuits, lighting all the required letters simultaneously. With two operators, legends may follow one another on the sign at intervals of fifteen seconds. The frame is 50 ft. long by 15 ft. high and carries more than 3000 lamps.

Disposing of Small Insects with a Suction Cleaner

Suction cleaners may be used to rid houses of flies, gnats, mosquitoes or any other small insects which hover around a bright light, according to a report from one of our readers living near Pittsburgh. There, last summer, swarms of little green gnats invaded the outlying districts and could not be kept out of homes by the ordinary netting. As the insects collected around lighted lamps, it was found possible to dispose of them quickly by holding the nozzle of a suction cleaner near the lamps for a few minutes.

NEW APPARATUS AND APPLIANCES

Protective Reactance Coils

In an article on porcelain-clad reactors that appeared in the Dec. 21, 1912, issue of the ELECTRICAL WORLD, use of protective reactance coils on feeders, generators, transformers and busbar circuits was advocated. Although installations of reactors at that time were somewhat limited, since then they have been generally adopted, and reactance coils are now considered a necessity for the satisfactory operation of central stations and distributing systems.

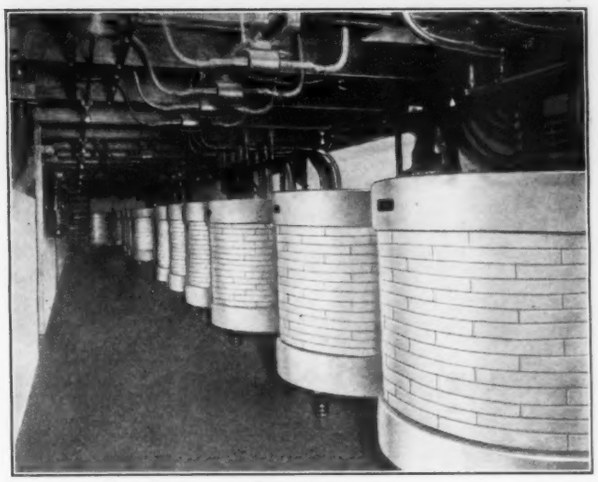


FIG. 1—REACTANCE-COIL ROOM, BENNINGS STATION POTOMAC ELECTRIC POWER COMPANY

As explained in the previous article, the main function of the reactance coil is to limit the amount of current that can flow into a short-circuit. By thus limiting the short-circuit current flow from one part of the system to another, the trouble is localized to the damaged section without materially impairing the rest of the service. As the mechanical stresses and heating are proportional to the square of the current, the increased protection to the apparatus by limiting the current is very marked. In addition to limiting the short-circuit current, the reactance coils afford considerable protection to the system by localizing high-frequency surges and thereby preventing them from spreading over the entire system. The large number of reactance coils that have been in service for a considerable time have proved their advantage in increasing the continuity of service and affording protection to apparatus.

In all cases the reactance coils should be placed as close to the bus as possible to protect the bus under the greatest number of conditions. As the operation of the system is entirely dependent upon the reactance coils at times of short-circuit, there cannot be too much stress laid on their factor of safety. In this respect reactance coils should be considered as a part of, and as reliable as, the high-tension bus.

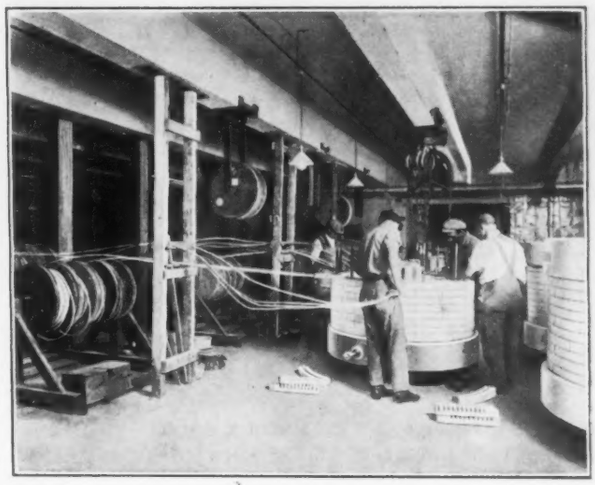


FIG. 3—REACTANCE COIL FOR 1000-KVA GENERATOR UNDER CONSTRUCTION

Central stations are now demanding, and manufacturers of turbo-generators are recommending, a total generator reactance (internal and external) of 10 per cent to 15 per cent. The higher value is for machines having a large amount of momentum. It is possible in many cases, especially with sixty cycles, to build generators with 10 per cent internal reactance, but many companies have found it advisable to install additional external reactance coils as a protection to the system against short-circuits in a generator and for limiting

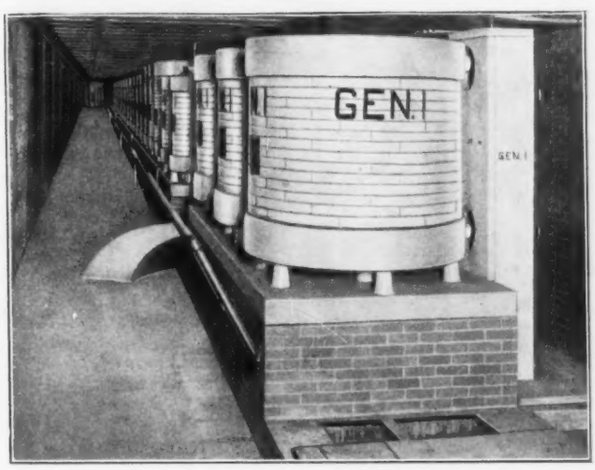


FIG. 2—PORCELAIN-CLAD REACTORS ON CIRCUITS OF TURBO-GENERATORS, NEW YORK EDISON COMPANY

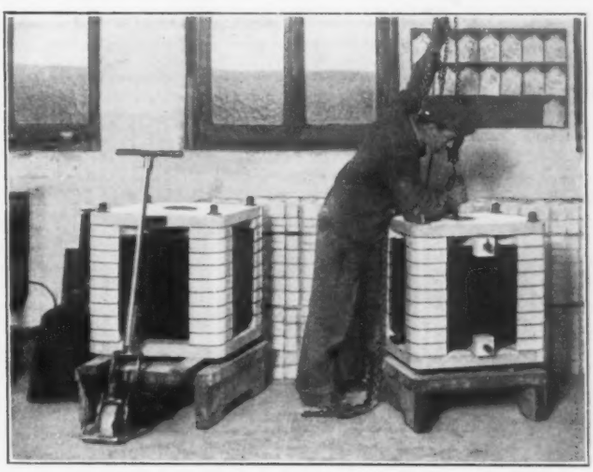


FIG. 4—SEMI-PORCELAIN-CLAD REACTORS FOR SMALL GENERATORS

the short-circuit current flow from the other generators on the bus.

With twenty-five-cycle generators of large size, it is impossible to build them with sufficient internal reactance without greatly increasing the cost and handicapping the design. Therefore the external reactance

FIG. 5—20 PER CENT BUS-SECTIONALIZING REACTANCE COILS BETWEEN STATIONS OF DETROIT EDISON COMPANY

coils for twenty-five-cycle generators are very essential for limiting the current in addition to protecting the system against any trouble that may arise within the generator.

Several porcelain-clad reactors for generators now in service are shown in Figs. 1 and 2. To the left in Fig. 3 some of the coils are shown under construction. Two recently developed semi-porcelain-clad reactors for small generators are shown in Fig. 4. The general construction of the porcelain-clad reactors was fully described in the previous article; in the latter part of this article is included a description of the semi-porcelain-clad type of construction.

There is considerable difference of opinion regarding the proper amount of reactance, carrying capacity and

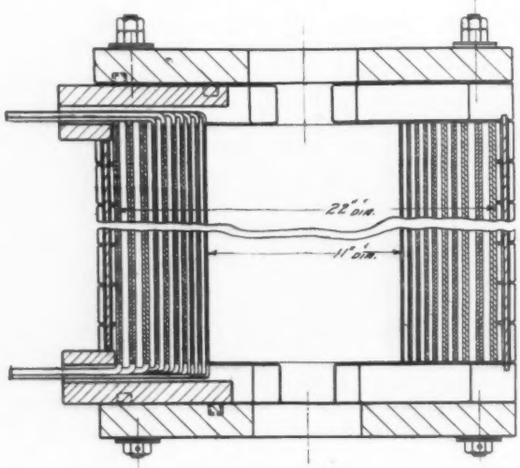


FIG. 6—ARRANGEMENT OF COILS IN SEMI-PORCELAIN-CLAD REACTOR

location of reactors for sectionalizing the busbar. These points are determined to a great extent by the local conditions of operation, which, of course, will vary considerably in different plants.

On a system where the feeders to the substations are from several sections of busbars and are paralleled at the substations the amount of bus-sectionalizing reactance must necessarily be small, as the parallel feeders act as a shunt to the reactance coils. This is more clearly illustrated in the curves shown in Fig. 11, where the division of current is given with various amounts of reactance on an underground 6600-volt, twenty-five-

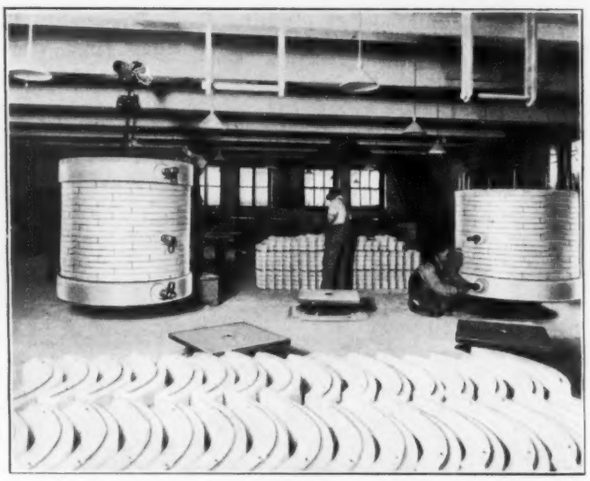


FIG. 7—COMBINED GENERATOR, BUS-SECTIONALIZING AND FEEDER-GROUP REACTOR UNDER CONSTRUCTION

cycle system. The per cent reactance is based on the full-load current of the bus section, and it is assumed that 50 per cent of the feeders on the bus sections are paralleled in substations at an average distance of 3 miles.

It is evident from these curves that there will be a certain amount of unequal division of current in the feeders when current is carried through the bus reactance coils. For the system cited above a reactance greater than 8 per cent reduces the short-circuit current very little and is undesirable from an operating standpoint.

The rating of the sectionalizing reactance coils must be equal to that of the sectionalizing switches, which

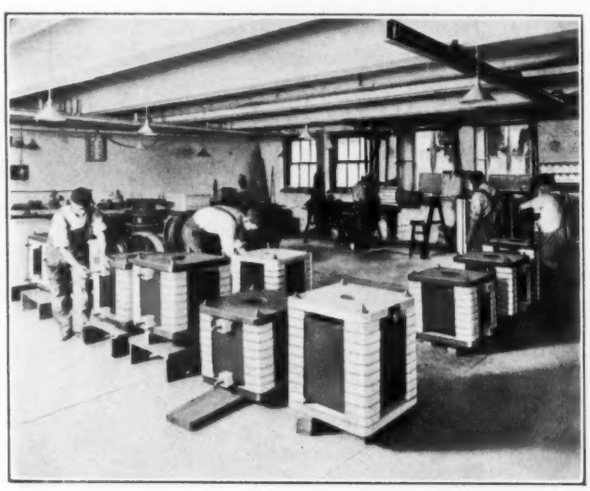


FIG. 8—VIEW OF REACTANCE COILS IN THE PROCESS OF MANUFACTURE

is determined by the amount of current flow desired from one section of the bus to the other. The ring-bus system (bus forming a loop) with sectionalizing reactance coils, as shown in Fig. 12, has the advantage of reduced current through the coils, as every section can be supplied from the two adjoining bus sections.

Fig. 5 illustrates an installation of porcelain-clad reactors on busbar circuits. The reactance coils shown to the right in Fig. 3 are also for busbar circuits.

The curves shown in Fig. 12 give the amount of short-circuit current in terms of the total generator rating

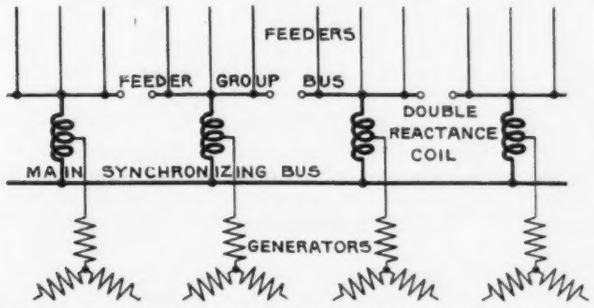


FIG. 9—ONE-LINE DIAGRAM OF COMBINED GENERATOR, BUS AND FEEDER-GROUP REACTANCE COIL

under various amounts of busbar reactance and with 10 per cent generator reactance. Where various sections of the busbars are paralleled in the substations, a correction must be added for the shunting effect of the

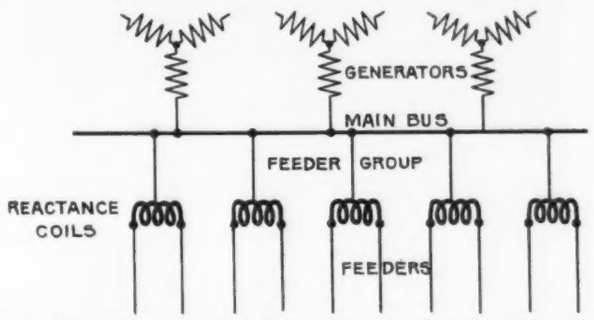


FIG. 10—ONE-LINE DIAGRAM OF REACTANCE COILS INSTALLED ON SPLIT-FEEDER GROUPS

feeders, as figured from the curves shown in Fig. 11. The curves in Fig. 12 show that it is desirable to divide the bus into a number of sections to reduce materially the short-circuit current. It is also evident from these curves that a permissible installation of bus-sectionalizing reactance coils is not sufficient protection for the numerous feeder short-circuits that are liable to occur on a system. Bus-sectionalizing reactance coils are, therefore, well adapted, it is declared, for protection

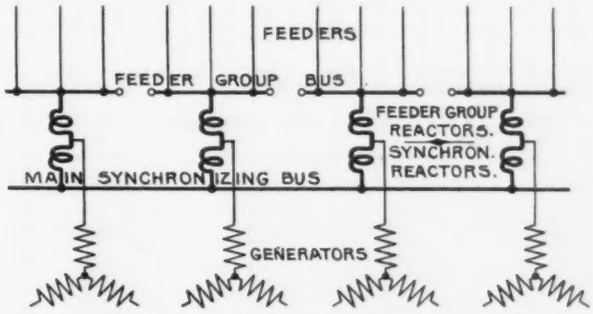


FIG. 14—ONE-LINE DIAGRAM OF FEEDER AND BUS SYNCHRONIZING REACTORS

and localization of any remote trouble that may occur on a bus section.

For combining the three very desirable protective parts of the circuits (generator, busbar and feeder) in

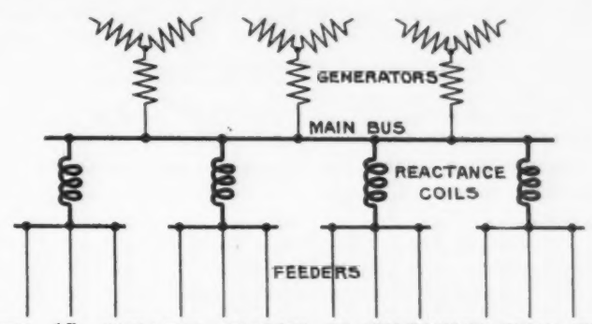
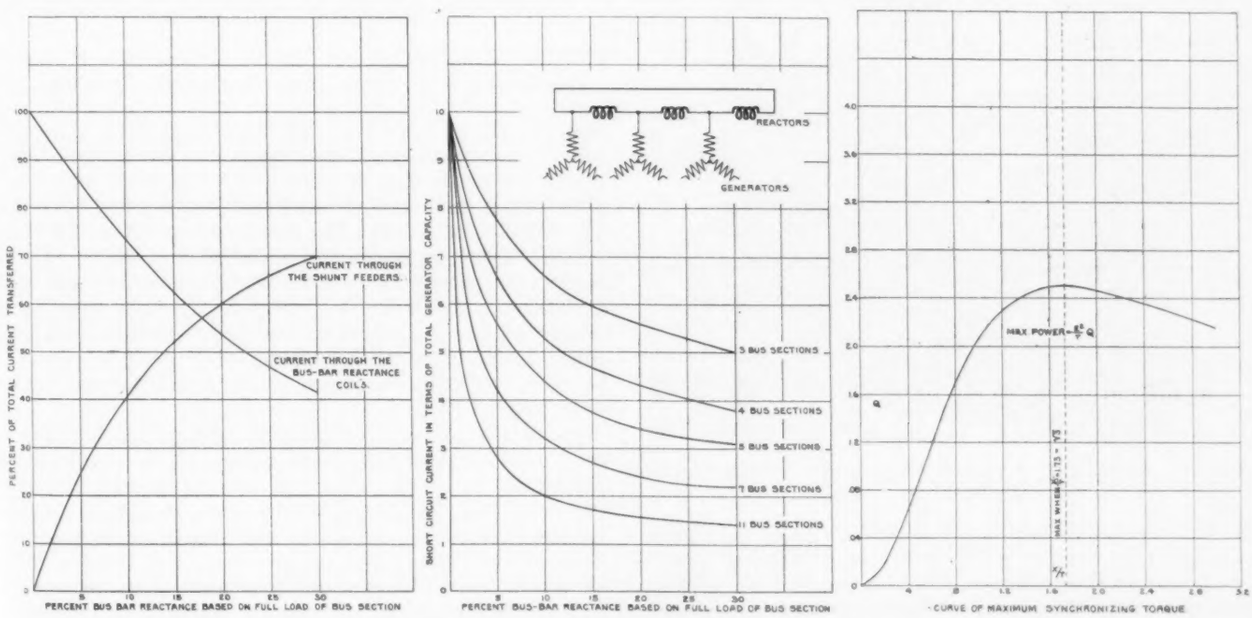


FIG. 15—ONE-LINE DIAGRAM OF REACTANCE COILS INSTALLED ON FEEDER GROUPS

one unit, mutually inductive reactors, as they are called, have been designed. Mutually inductive reactors protect the generator from excessive short-circuit currents, protect and localize any trouble on a bus sec-


PERCENT OF TOTAL CURRENT TRANSFERRED
CURRENT THROUGH THE SHUNT FEEDERS.
CURRENT THROUGH THE BUS-BAR REACTANCE COILS.
PERCENT BUS BAR REACTANCE BASED ON FULL LOAD OF BUS SECTION
SHORT CIRCUIT CURRENT IN TERMS OF TOTAL GENERATOR CAPACITY
REACTORS
GENERATORS
3 BUS SECTIONS
4 BUS SECTIONS
5 BUS SECTIONS
7 BUS SECTIONS
11 BUS SECTIONS
PERCENT BUS-BAR REACTANCE BASED ON FULL LOAD OF BUS SECTION
MAX POWER = E²/2 Q
CURVE OF MAXIMUM SYNCHRONIZING TORQUE

FIGS. 11, 12 AND 13—DIVISION OF CURRENT WITH VARIOUS AMOUNTS OF REACTANCE ON UNDERGROUND 6600-VOLT SYSTEM; VARIATION OF SHORT-CIRCUIT CURRENT AND BUSBAR REACTANCE FOR RING-BUS SYSTEM, AND CURVE OF MAXIMUM SYNCHRONIZING TORQUE

tion, and materially reduce, it is claimed, the short-circuit current into feeder troubles.

A combined system of reactance coils, as shown in Fig. 9, 14 or 16, has been installed with good results. It is evident that the installation of the mutually inductive reactance coils of Fig. 9 or 16 is superior to the arrangement of two separate generator and feeder

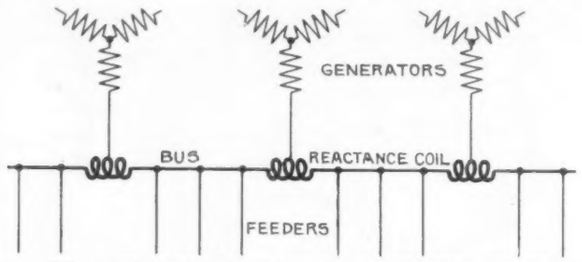


FIG. 16—ONE-LINE DIAGRAM OF COMBINED GENERATOR AND BUS REACTANCE COILS

group reactors, as shown in Fig. 14, for the following reasons: First, the space required is very much less; secondly, the mutual inductance between the two sections of the coil limits the current to a greater extent for a given amount of copper; thirdly, a short-circuit disturbance causes less voltage drop on the remainder of the bus, as the current in the short-circuit is made to assist in keeping up the pressure on the rest of the system.

The mutually inductive reactors are said to afford a great saving in the cost and installation of protective systems with increased efficiency and reliability of service. Some of these coils under construction are shown in Fig. 7.

Experience has shown that a large percentage of the break-downs originate in the feeder circuits, and therefore the use of feeder-reactance coils for minimizing this trouble is rapidly gaining favor. Moreover, with reactors on feeders the heavy stresses upon the circuit-breakers are lessened, thereby insuring safe operation and making possible the use of smaller and cheaper circuit-breakers in small-sized and moderate-sized plants.

Reactance coils were first installed on the most troublesome feeders, which in most cases were of small rating. These installations have proved so effective in eliminating the former serious interferences with the continuity of service that they are being adopted for large feeders. In many cases all of the feeders connected to the station bus are equipped with reactors.

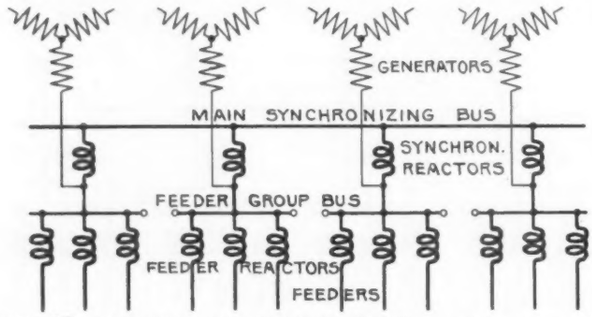


FIG. 17—ONE-LINE DIAGRAM OF FEEDER AND BUS SYNCHRONIZING REACTORS

In the previous article a number of curves were given to show the reduction in the energy flowing into a feeder short-circuit effected by the installation of reactactance coils. The curves in Fig. 19 show corresponding reduction in short-circuit currents. The several curves are given with various ratios of total rating to the rating of the individual feeder under consideration, with 10 per cent reactance in the generating circuit. It is evident from these curves that a very small per cent reactance on a small feeder (ratio or total rating to feeder rating being large) reduces the short-circuit current to practically a negligible quantity. The small percentage of reactance makes also negligible the effect on the regulation of the feeder.

With reduction in the feeder short-circuit current, the relay system can be made far more selective, the voltage of the system will not be materially affected, and there will be no rapid change in the system frequency. This prevents the synchronous apparatus connected to the system from falling out of step, and the defective feeder will be automatically disconnected from the system without interruption of service to the remainder of the system.

The installation of reactors on special feeders to private customers, from generating stations or substations, is of particular importance, as these feeders are usually small, poorly operated and give considerable trouble. In many cases a small reactance coil installed on these feeders will eliminate a large percentage of the system disturbances. Some companies have installed reactance coils on feeder groups (see Fig. 15) but it is evident from the curves in Fig. 19 that they require a total kva in the reactance coils considerably larger than that which would be required for coils on each feeder to give the same amount of protection.

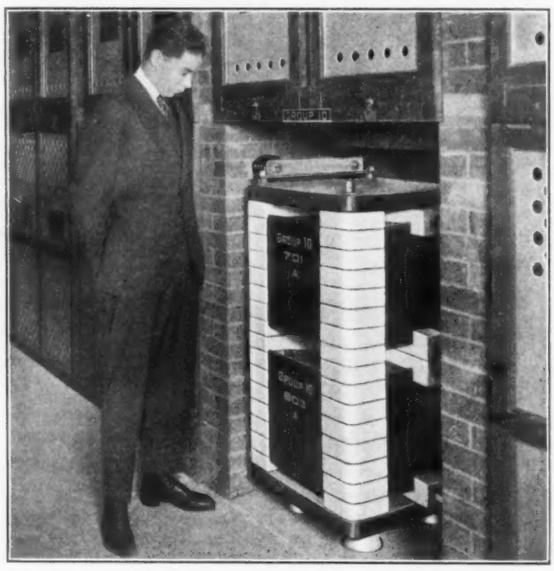


FIG. 18—REACTOR ON THE SAME PHASE LEGS OF TWO-FEEDER CIRCUITS, UNITED ELECTRIC LIGHT & POWER CO.

An efficient reactance coil installed on a group of two feeders is shown in Fig. 18 with a one-line diagram of connections shown in Fig. 10. In this case each feeder leg has its reactance coil fed from the center of the coil, and as a result considerable saving in space is obtained with the same amount of protection as is had with two coils.

A certain amount of reactance is required in station tie lines, where synchronous apparatus is involved at both ends, to increase the stability of operation. The curve in Fig. 13 shows the increase in synchronizing torque effected by increasing the reactance in the circuit. It is evident from this curve that there should be about 73 per cent more reactance than resistance in such tie lines to get the maximum stability of operation.

In the design of feeder reactance coils the following points are considered essential:

First, the coils must have a high factor of safety which should be equivalent to that of the bus to which it would be connected. To accomplish this, the coils must be incased in supports having positive insulating properties (perferably porcelain) under all conditions. The windings which would have a considerable potential (50 volts to 100 volts) between turns at time of short-circuit should be protected by septums or be insulated and saturated with an insulating compound which will withstand high temperatures. This separation is also desirable for protection against accidental moisture, dust or foreign objects settling between the windings.

Secondly, the coils must be self-cooled with a moderate-temperature rise well within the limits of the insulation.

Thirdly, the coils must require a small space for the installation, which is simple and inexpensive.

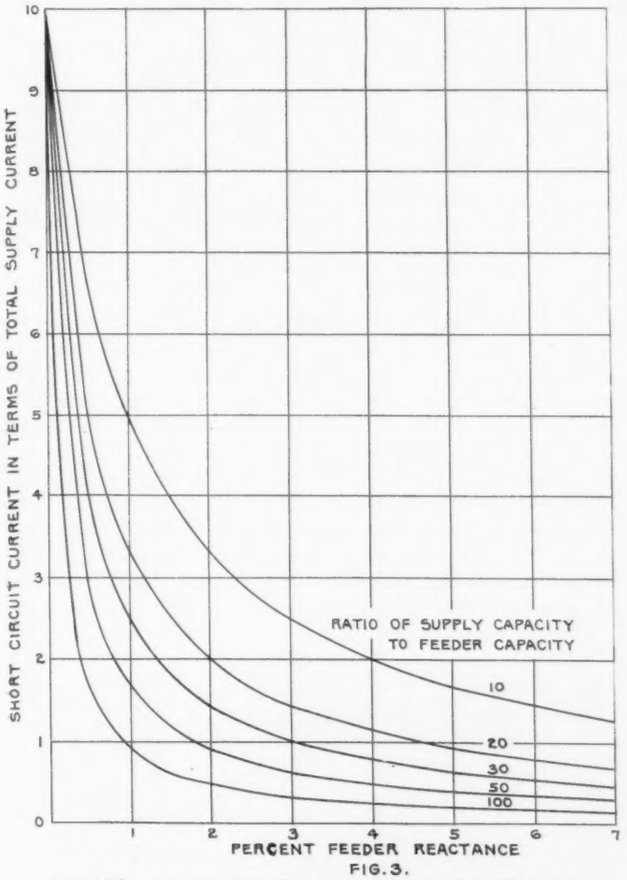


FIG. 3.

FIG. 19—REDUCTION IN SHORT-CIRCUIT CURRENTS

Fourthly, the cost of the coils complete must be moderate.

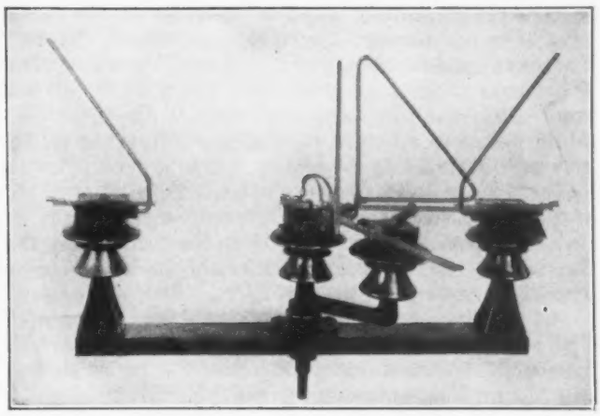
Figs. 8 and 18 show some semi-porcelain-clad reactance coils. These coils are made up of a number of concentric coaxial solenoids in parallel, which is said to give a uniform potential gradient from top to bottom (see Fig. 6). The insulating space required between layers is practically eliminated, which results in a large reduction in size and increased efficiency of the coils.

Some companies are installing a modified system of reactance coils as shown in Fig. 17. This arrangement has the advantages of maximum protection by the use of feeder reactance coils combined with the additional advantage of the synchronizing reactance coils acting as a generator and bus-sectionalizing reactance.

The reactance coils described and illustrated above are the product of the Metropolitan Engineering Company, Brooklyn, N. Y.

Double-Throw Horn-Gap Switch

A single-pole unit of a recently developed double-throw horn-gap switch is shown in the accompanying illustration. The main contacts of the switch are protected by auxiliary arcing horns. A feature of this device, it is declared, is two blades which are placed at an angle of 60 deg. from each other. With two blades

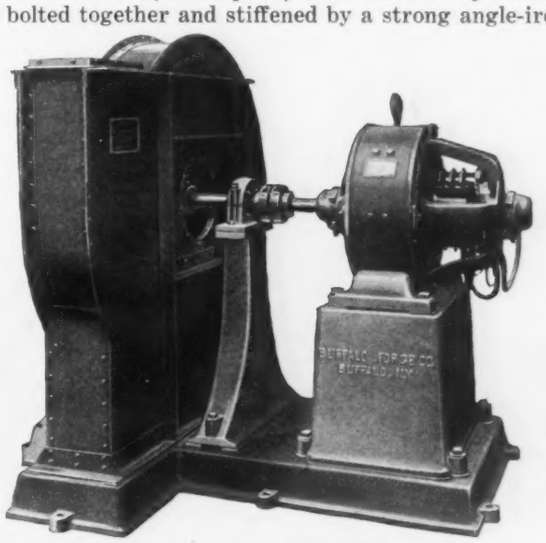


SINGLE-POLE UNIT OF DOUBLE-THROW HORN-GAP SWITCH

mounted in this way, the switch is rotated through an angle of less than 120 deg., thereby permitting the use of a simple crank and connecting bar-type operating mechanism for interconnecting three such units for simultaneous operation. The equipment is being made by the Railway & Industrial Engineering Company, Pittsburgh.

Steel-Plate Pressure Blowers

The high-pressure blower shown herewith is designed especially for cupola or furnace service and is directly connected to a motor by a flexible coupling. The fan is mounted on independent pedestal bearings, and the entire outfit is on a cast-iron sub-base. The housing of the fan is of heavy steel plate, which is securely riveted and bolted together and stiffened by a strong angle-iron



HIGH-PRESSURE FAN CONNECTED TO MOTOR

spring. The blast wheel is also of heavy steel plate and is mounted on a malleable-iron spider or hub. The blades or vanes are riveted to heavy steel-plate flanges and the principal blades are also riveted to the spider arms. Fans of this type deliver air at pressures up to 16 ounces per sq. in. The fan is being made by the Buffalo Forge Company, New York.

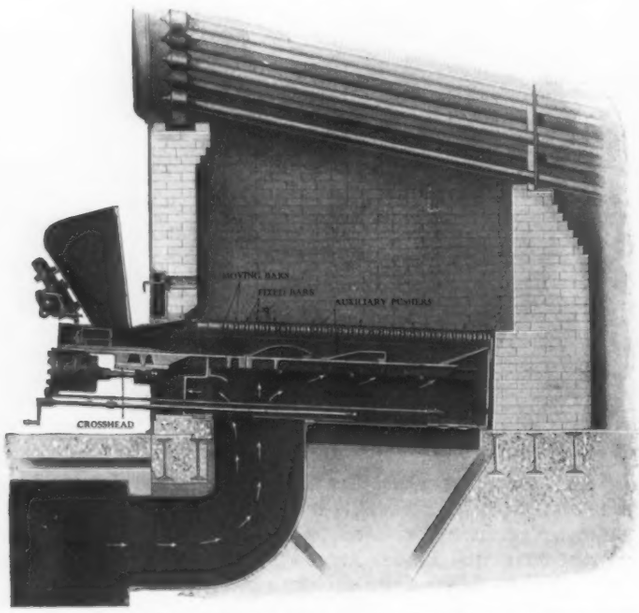
Underfeed Stoker

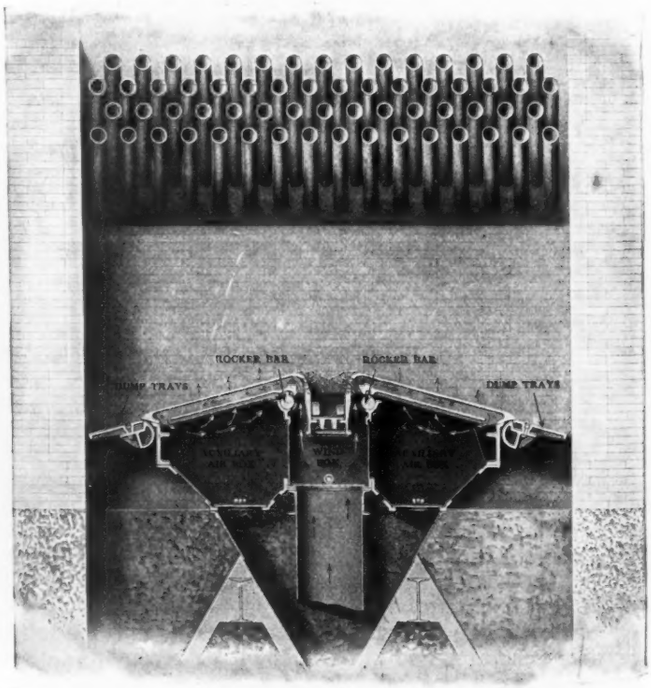
A stoker of the underfeed type has been developed by the Combustion Engineering Corporation, 11 Broadway, New York. Coal is fed into a large hopper and is passed under the fire by means of a reciprocating sliding bottom of the feed trough or retort which runs the full length of the stoker. It is delivered uniformly from front to rear by the auxiliary pushers, and as it rises in the trough is distributed to the sides of the furnace by means of moving bars, which are shown in Fig. 1. The burning fuel is constantly carried by the action of these bars to the dumping trays along each side wall, where the resulting ash or clinker is deposited. The sliding bottom is driven by a steam piston the cylinder of which is bolted to the stoker frame under the hopper.

The feeder block is fastened to the sliding bottom and forces the coal onto it, not only carrying the coal into the furnace but forcing it to rise the full length of the retort. As the coal rises in the retort it spreads over the fire bars shown in Fig. 2, which are arranged in pairs, one bar moving and the other being fixed. The moving bars work transversely to the retort, the motion being horizontal at the inner or retort end and slightly inclined at the outer end, the extent of motion being about 1 in. The movement of the fire bars, in addition to carrying the burning fuel to the sides of the furnace, also causes the clinker and ash to be moved to the dump trays. As the motion of the fire bars at the outward end is slightly up and down, any clinker present is prevented from forming in large pieces.

Air for combustion purposes after entering the wind box passes upward along each side of the retort and is discharged partly through the tuyère openings in the inside or retort end of the fire bars. The remaining air passes through the hollow fire bars, which are of box-like cross-section, and is discharged into the auxiliary air boxes. From these chambers the air enters the fire through narrow openings between the fire bars. The arrows in the illustrations show the path of the air. Provision is made to admit forced draft under the dump trays to increase the effective grate surface when it is desired to increase the capacity of the apparatus or burn out rapidly the coke on the dump trays before dumping.

The maximum thickness, it is claimed, of the fire does not exceed 8 in. to 12 in. with coking coal and 4 in. to 8 in. with non-coking coal. The stoker is built in sizes ranging from 6 ft. wide over dump trays to 13 ft. wide. For very wide furnaces two stokers are usually employed. The coal feeding capacity per stoker varies from 200 lb. to 9000 lb. per hour.

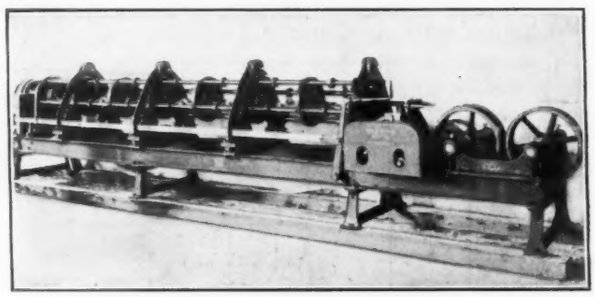




FIGS. 1 AND 2.—LONGITUDINAL SECTION THROUGH CENTER OF RETORT, AND CROSS-SECTION OF STOKER

High-Speed Wire-Stranding Machine

Stranding machines which operate at high speeds have recently been developed by the New England Butt Company, Providence, R. I. These machines are designed to make bare copper strands or to combine insulated wire or strands into cables. In the accompanying illustration is shown a seven-reel machine which



SEVEN-REEL WIRE STRANDING MACHINE

takes spools 7 in. to 9 in. in diameter. It operates at a speed of 800 r.p.m. Smaller machines of the same type are being made for fine wires, and they operate at speeds up to 1300 r.p.m. Large machines are also being built which take spools with diameters as high as 32 in. On account of the high speeds obtained, the machines are accurately balanced and are equipped with ball bearings. The main bearings and driving gears are inclosed in oil-tight cases. Machines are being built in the two-head tandem form, consisting of seven-reel and twelve-reel sections, and also in the single-head form with as many as nineteen reels in one section.

Turbo-Generator Sets with Impulse Turbines

Direct-current and alternating-current turbo-generator sets are being made by the Ridgway Dynamo & Engine Company, Ridgway, Pa., the turbines of which are of the high-speed, mixed-pressure or bleeder impulse types. The turbines are built under licenses of the owners of the patents, Prof. A. Rateau, of Paris, France, and Mr. C. H. Smoot, of New York.

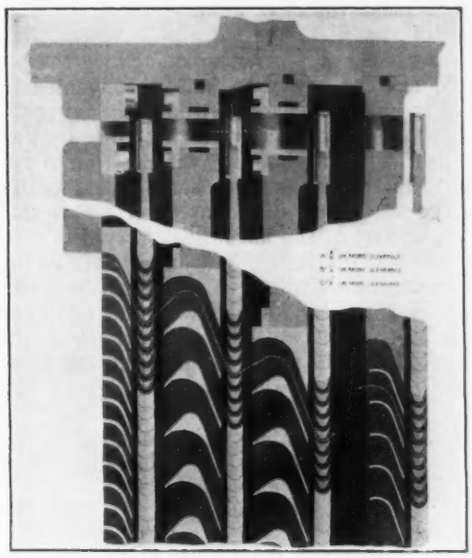


FIG. 1—SECTION OF NOZZLES, BUCKETS AND WHEELS

As shown in Fig. 1, the steam enters through a set of stationary nozzles in which it expands to a lower pressure with a corresponding increase in velocity. As the steam issues from the nozzles it strikes the entrance edge of the first row of buckets and, passing through them, its direction is changed, giving up energy to the buckets and driving them forward. While the velocity of the steam has been reduced during the passage through the buckets, no expansion occurs, and hence its pressure is the same on the leaving as on the entering side and is uniform in the entire space between the first and second nozzles. The steam next passes through the second set of stationary nozzles, which are of greater area than the first. The steam again expands and enters the second row of buckets at the same velocity as when entering the first. The steam passes through the second row of buckets in the same way as through the first, and the process is repeated in succeeding stages until it reaches the exhaust outlet. Since the steam in

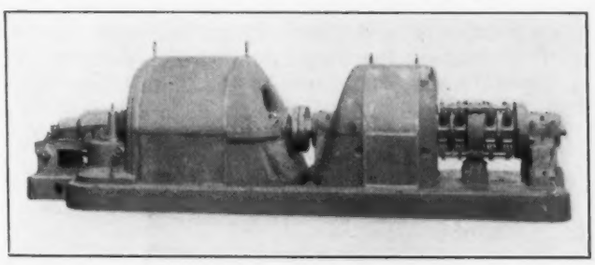


FIG. 2—MIXED-PRESSURE TURBO-GENERATOR UNIT

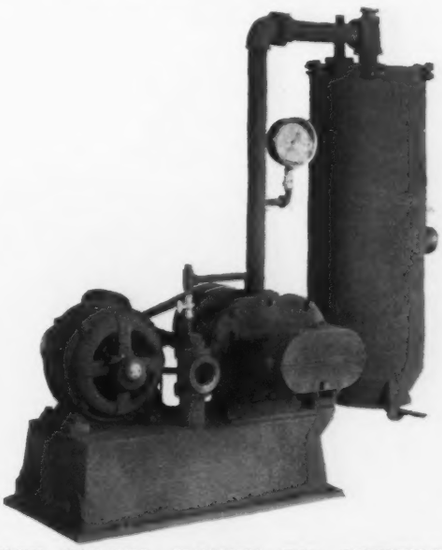
the space between any two nozzles is at uniform pressure—that is, on both sides of the bucket—there is no tendency, it is declared, for it to leak past or around them. According to the manufacturer, there are also no forces acting on the buckets parallel to the shaft, and, moreover, there is no necessity for close running clearances between buckets and nozzles and casing.

The wheels of the rotating element which carry the buckets are machined from disks of flange steel and are keyed on the shaft. They are also separated from each other by steel collars on the shaft. The buckets are machined from solid bars of a special alloy and are made in two types, depending on their size. The shape and construction of the smaller buckets are shown in Fig. 1. Large buckets are provided with bulb ends which are driven into slots in the periphery of the wheel and peened solidly in place. Each bucket of either type carries its own shroud and when assembled on the wheel is in rigid contact at the outer end with the adjacent buckets.

The casing and heads of the stationary element are split horizontally, and the upper halves can be easily lifted in case it is necessary to open the turbine. The diaphragms are also split, and the top halves are fastened to the top of the casing and lift with it. The steam and exhaust connections are fastened to the lower half, and they are not disturbed when the turbine is open. The nozzle construction varies in the various diaphragms, depending on the area required. Nozzles with small areas are solid castings of a special alloy. Such nozzles are used in the first stages and are bolted in place. In later stages the blades forming the nozzles are cast in place in the diaphragm and extend all or part way around the periphery of the diaphragm. The governor is of the throttling type, and the valves are directly connected to the fly-ball governor mounted on the end of the main turbine shaft.

Stationary Motor-Driven Vacuum Cleaner

A stationary vacuum cleaner operated by a 0.5-hp motor and designed for use in residences and apartment houses is shown in the accompanying illustration. The exhauster is of the two-shaft type and is mounted on a cast-iron base with the motor and dust tank. The machine is belt-connected to the motor, and by lifting a gravity idler the belt can be slipped off and the motor



STATIONARY VACUUM CLEANER FOR RESIDENCES AND APARTMENT HOUSES

used for other purposes. According to the manufacturers, the exhauster operates without internal contact, friction or wear. The clearance spaces between the rotating parts of the case are sealed by water automatically drawn from and discharged back into the base. The dust separation is accomplished by means of a canvas bag which is shaken mechanically by means of a

top plug and a chain. The bag can be removed by lifting it with the top plate.

The vacuum cleaner is being made by the Atwood Vacuum Cleaner Company, 204 South Church Street, Rockford, Ill., and is operated by a motor of Westinghouse Electric & Manufacturing Company make.

Electric Butt-Welding Machines

The electric welding machine shown in Fig. 1 was built for the Saco Lowell Shops, Biddeford, Me., manufacturers of spinning machines, and is used to make shafts varying from 1.75 in. to 1.25 in. in diameter

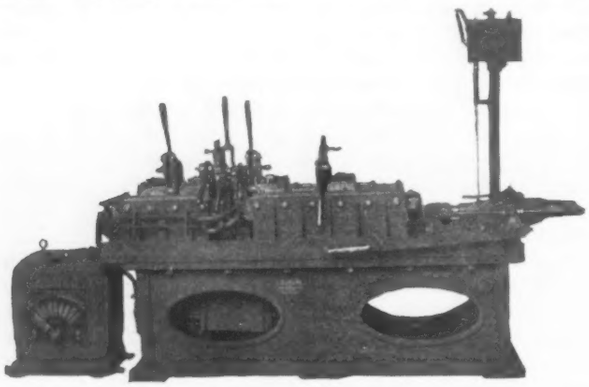


FIG. 1—WELDING MACHINE FOR MAKING 40-FT. SHAFTS

and from 30 ft. to 40 ft. in length. Formerly the rods were made in pieces, the ends being drilled and tapped and threaded pins being inserted in the tapped holes to hold them together; but with this method it was impossible to obtain correct alignment or the strength required. The welding machine illustrated is designed to weld rods together up to 40-ft. lengths, which are correctly aligned and are concentric within 0.004 in. According to the manufacturers, the extreme accuracy was obtained by making the clamping mechanism so massive that there is no perceptible spring in any part

FIG. 2—SPOT-WELDING MACHINE

after the pieces are clamped in place and the necessary pressure applied to force the stock together.

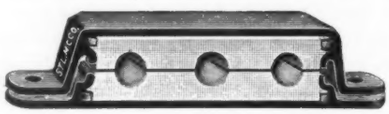
The copper dies for conveying the energy to the rod are so-called "floating" dies, which are brought up to the work after the stock is clamped into position in order to avoid throwing the pieces out of alignment. The circuit is closed by means of a switch, and in about fifteen seconds the ends of the rod are heated to the welding temperature, when a pumping motion on the lever handle, shown in the front of the machine, operates a 5-ton hydraulic ram which forces the ends of the semi-molten stock against each other and gives a perfect weld. The dies are then withdrawn from the rod, the clamps that hold the stock are released, and the operator is ready to make the next weld.

A special spot-welding machine is shown in Fig. 2 which is designed for heavy work. Since the pieces to be welded are too heavy to handle conveniently, it is necessary to make the welds without changing the position of the stock. For this work three different kinds of dies are used without changing the position of the stock after it is placed on the lower horn of the welding machine. The die point is mounted on a swiveled head on the upper part of the machine. A weld is made with one die; the next die is swung around to strike the stock in a different place, and the third die makes a weld in a still different spot, all of the welds being made in a radius of 4 in. The stock is then removed, the next piece inserted and the welds are made in the same manner as before, only in the reverse order of that just described.

The two welding machines described above were made by the Toledo Electric Welder Company, Cincinnati, Ohio.

Insulated Racks for Cables

In the insulated racks for cables shown in the accompanying illustration each half of the porcelain insulators is made in a single piece and fastened in its respective casting so that when laying the cable in the grooves no attention or labor is required to hold the

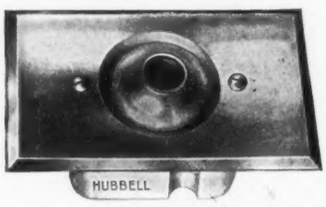


INSULATED RACK FOR CABLES

insulators in place. The metal parts are of malleable iron. These racks, which can be furnished in sizes for carrying from one to five feed wires, are made by the St. Louis Malleable Casting Company, 7700 North Broadway, St. Louis, Mo.

Flush Receptacle with Recessed Plate

The receptacle and plate shown herewith are recessed, permitting the deep insertion of the cap so that the top of the cap is flush with the plate. The recep-



RECESSED RECEPTACLE AND PLATE FOR DEEP INSERTION OF CAP

tacle is provided with T-slot contacts with which seventeen different types of caps can be employed. The devices are being placed on the market by Harvey Hubbell, Inc., Bridgeport, Conn.

CURRENT NEWS SECTION

Conferences with Federal Trade Commission

Men connected with different industries in various parts of the country have been in Washington lately for conferences with members of the Federal Trade Commission. These have included men of "big" business as well as those identified with smaller industries. Responding to the announcement of Chairman Davies, that the commission would always be glad to confer with business men, a number are said to be highly gratified at the treatment they have received and to have gone away impressed with the belief that the commission is endeavoring to co-operate with business in every way.

The interviews which have been held so far have been entirely informal and cannot be characterized as having been in any sense "hearings" such as the Interstate Commerce Commission holds. Business men have been invited into the conference room of the commission with only the commissioners present. No stenographic reports have been made, although stenographers have occasionally been furnished after conferences in case business men desired to dictate statements to be filed with the commission.

It is expected that a week or more will elapse before the commission will get far into the question of policies, as to which no conclusions have been reached so far, although there has been discussion. Administrative details in connection with taking over the old Bureau of Corporations are engaging the attention of the commission.

Annual Meeting of Winnipeg Contractors

The Master Electrical Contractors' Association of Winnipeg, Manitoba, held its first annual meeting in the St. Regis Hotel, Winnipeg, on March 25. President R. L. Riggs extended the association's welcome to those present and explained the aims of the organization and its history. President J. W. Marsh of the Standard Underground Cable Company, who was visiting the city, was called upon by Mr. Riggs for a few remarks and responded with a ten-minute address of encouragement of the purposes of the association and of optimism as to the ultimate prosperity of Canada.

The rest of the afternoon was given to consideration of six addresses on trade subjects. Mr. J. H. Schumacher, on "Efficiency in the Electrical Contracting Business," devoted himself mainly to the estimating and inside office work, too often slighted, of the electrical contractor, and presented some very helpful suggestions. Mr. S. A. Barber, on "Competition and the Electrical Contractor," gave a short history of the varying competitive conditions during the past ten or twenty years. Mr. H. W. Billing, on "The Jobber in the Field," told of some of the jobber's problems as they affect the business of the electrical contractor. Mr. C. Marriott, on "The Contractor in the Field," recounted experiences in the Winnipeg electrical contracting field, and his happy knack of humorous and pithy expression was well brought out by his address. He made a strong plea for the elimination of cut-throat competition and for co-operation to raise the status of the electrical contractor, expressing appreciation of the work of the city electrician's department and of the help its inspection was to the contractor who stood for "quality" work. Mr. C. T. Kummen read a very instructive paper on "Credits," gave the various points which go toward making good credit standing, and pointed out the need of extending credits with as much care as the banker uses in extending credit to the contractor. Mr. F. A. Cambridge, city electrician, brought the meeting to a close with a very interesting paper on the "Evolution of the National Electrical Code."

Transportation for N. E. L. A. Convention

The transportation committee of the National Electric Light Association, of which Mr. George W. Elliott is chairman, has issued an itinerary for the "green special" tour to the convention to be held in San Francisco on June 7 to 11. In addition to the scenic attractions, the "green special," which will start from Chicago, will make as many stops as possible at various hydroelectric plants and transmission systems. Notable among these are the Keokuk dam, the Big Creek development at Cascada, Cal., and the hydroelectric development at Lake Spaulding.

Many reservations are being made for the various tours, about three-quarters of the space on the "red special" having already been engaged.

Merger of Western Hydroelectric Properties

Advices from Boise, Idaho, state that during 1915 the Electric Bond & Share Company, New York, will merge into one large subsidiary company the controlled electric corporations operating in southern Idaho, Utah and, unless present plans are altered, possibly Montana and Washington. It was stated in Boise that the merger will include the three hydroelectric power companies, the Idaho-Oregon Light & Power Company, the Idaho Power & Light Company and the Idaho Railway, Light & Power Company. The Southern Idaho Water Company is reported to have agreed to enter the merger. As soon as contracts of the Great Shoshone & Twin Falls Water Power Company can be arranged that corporation, according to the report, will be acquired.

The merger outlined includes all of the larger hydroelectric power companies in southern Idaho and Utah. It is reported also to be the plan to acquire holdings of the Washington Water Power Company, the Southern Idaho Water Power Company and the Great Shoshone & Twin Falls Water Power Company, the two latter companies being now controlled by the American Waterworks & Electric Company of New York. Both of these companies were transferred shortly after the Kuhn failure and are now serving the Pocatello and Twin Falls territories. Recently the Public Utilities Commission of Idaho authorized the Idaho Power & Light Company to enter the Twin Falls field, but that concern has practically ceased construction work there and recently large forces of men were laid off. The National Sureties Company is a subsidiary of the Electric Bond & Share Company reported to have been organized to consolidate the hydroelectric corporations concerned in the plan.

Municipal Ownership Discussed in Watertown, N. Y.

A meeting of the Chamber of Commerce of Watertown, N. Y., was held on April 3 for consideration of a plan to establish a municipal lighting plant. Mr. Howard C. Hopson, formerly chief of the division of capitalization of the New York Public Service Commission, Second District, gave a talk. He criticised a report rendered recently by Mr. H. B. Sweet, of Utica, N. Y., on the proposed plant.

In speaking of the water rights owned by the city, Mr. Hopson assumed the value of the power undeveloped to be $150,000. In addition to the amount already spent by the city for labor and material further engineering costs and interest should be added. It would take $162,000 to complete the development, making a total cost of $250,360. Adding the valuation of the property would make the aggregate $405,360. Figuring interest and depreciation, with an allowance of fifty years as the life of the development, and calculating repairs, the fixed charge alone would be $27,929. There would be a loss of taxes to the city on account of the change from private to municipal ownership, and other fixed charges would accrue in connection with transmission of energy to the waterwheel and the cost of the proposed bridge. In seven years three different methods of street lighting have been used in the city, and these changes have necessitated material replacements.

Mr. Hopson said that the item of depreciation has wrecked more plans of promoters of lighting companies than has any other feature.

Electrical Rules of Boston Fire Commissioner

Fire Prevention Commissioner John A. O'Keefe of the Boston (Mass.) metropolitan district has issued a number of regulations bearing upon safeguarding garages and motion-picture establishments containing electrical equipment. The new rules provide that no system of artificial lighting other than incandescent electric lamps shall be installed in any garage, and that all wiring for lighting, battery charging and electrical equipment generally must be at least equal to that required by the National Electric Code, with additional requirements as follows:

All cut-outs, outlet and junction boxes, switches, receptacles, connectors or other live metal parts, motors, dynamos, and all apparatus capable of emitting a spark, must be placed 4 ft. above the floor or outside the garage, except motors, dynamos and magnetos incased on automobiles. All electrical apparatus capable of spark emission, if not fully inclosed, must be provided with brass wire screen of No. 14 mesh or finer over openings exposing sparks. Flexible cords for portable lamps, motors or other apparatus must be reinforced for rough usage. The live end of the cord must be the projecting part of an approved pin-plug connector so constructed that it will break apart readily at any position of the cord, and the opposite end, if terminating in a connector, must be the projecting part and protected against accidental contact. Flexible cables for battery charging must be of approved theater-stage type and have approved connectors of at least 50-amp rating constructed and arranged as described in the foregoing sentence. All new portable lamps must be equipped with approved keyless sockets attached to approved portable-lamp guards with handles and hooks. All new wiring in garages except flexible cords and cables, as specified in the foregoing, and those used for pendent lamps must be installed in approved metal conduit or armored cable, except that approved metal molding may be used in offices and showrooms.

No system of artificial lighting other than electric incandescent lamps is permitted in any room used for the storage, keeping and handling of inflammable motion-picture films. The National Electric Code is required in wiring, with screening-in of spark-emitting apparatus. All flexible cords must be reinforced for rough usage, and lamps on flexible cords which are long enough to allow the lamps to come within 6.5 ft. of the floor when hanging vertically must be protected by vapor-tight globes and wire guards attached to the sockets. Tying off from the normal position is forbidden if there is any danger of breakage if the tie is broken. All electric lamps in storage rooms must be provided with vapor-proof globes, safely placed. Any other electric lamp, if so placed that the films can be set or are liable, while being handled, to come within a distance of 18 in. from it, must be provided with a vapor-proof globe and properly guarded. All electric lamps in storage and examining rooms, vestibules and exhibition booths must be provided with wire cages attached to approved keyless sockets, and the switches for operating these lamps must be placed outside the rooms or booth. All wiring in rooms used for the storage, keeping or handling of films must be installed in approved metal conduits or armored cable.

Distribution of Employees' Fund in Cleveland

At the annual distribution of the employees' fund, the Cleveland (Ohio) Electric Illuminating Company paid to 748 of its 1000 employees in cash or deposited to their accounts more than $55,000. This represents 8 per cent on their wages or salaries. Of the total, 3 per cent, or more than $20,000, was paid in cash and the other 5 per cent was deposited to the credit of employees in savings banks where it will earn 4 per cent interest.

All employees who have been with the company one year or more may participate in this dividend. At the end of ten years of service they may withdraw their deposits. If they leave the company before the expiration of ten years, they may withdraw their deposits, provided they give thirty days' notice. This plan has been in operation eleven years.

Changes in Western Electric Directors

At the stockholders' meeting of the Western Electric Company the only matter of special interest was the change in personnel of the board. Provisions of the Clayton law are evidently intended to prevent a company which supplies material, through the fact that its representatives have a place on the board of a common carrier, from exerting improper influence upon purchases of the common carrier. The Western Electric Company, which is largely owned by the American Telephone & Telegraph Company, is virtually the manufacturing and supply department of the telephone company, and the telephone company has been represented upon its board of directors, so that while the relation between the companies is the exact opposite of that at which the law was aimed, the companies technically come within the prohibited relation.

To comply with this law it was necessary either to adopt a method of operations between the Western Electric Company and the telephone companies which would increase expenses largely, or to drop from the board of each company all representatives of the other. Although the law allows two years in which to make adjustments, under the policy of the Bell system, when a law is

known and understood, to comply at once, Mr. Thayer retires as vice-president and director of the American Telephone & Telegraph Company, and Mr. Vail and his associates in the telephone company retire from the Western Electric board, which has been reduced in number.

The new members of the board of the Western Electric Company are men who have long been connected with the company. The board as now constituted consists of Messrs. E. M. Barton, H. A. Halligan, W. H. Miner, A. L. Salt, W. P. Sidley, Gerard Swope and H. B. Thayer.

Cleveland Municipal Situation

Mr. F. W. Ballard, commissioner and chief engineer of the division of light and heat of Cleveland, Ohio, has announced the proposed issue of a bulletin at an early date containing a full statement of the operating income and expenses of the new municipal plant for 1914, together with other pertinent information.

On April 1 a local Cleveland newspaper criticised Mr. Ballard because of the statement published in two other papers, purporting to be from him, that an examination made by the State Auditor showed profits of $30,000 for 1914. Mr. C. S. Metcalf, State examiner at Cleveland, said that no official examination of the light accounts of the city had been made since 1912. Mr. Metcalf said that he checked the bond vouchers from Jan. 1 to Sept. 1, 1914, and accepted Mr. Ballard's figures for the remainder of the year. An unofficial statement containing these figures was sent to the State Auditor. The City Council has arranged for an audit of the books of the division by independent auditors.

At a hearing before the Public Utilities Commission in Columbus on March 31 Attorney Thomas Hogsett, representing the Cleveland Electric Illuminating Company, offered on behalf of the company to pay one-half of any sum necessary to complete the valuation of the property speedily, on condition that the city contribute a like sum. City Solicitor John N. Stockwell said that he would be glad to take up the matter with the City Council and recommend action to that end.

Chief Engineer L. G. White of the commission said that forty men would be able to complete the appraisal in about four months and that the cost would probably be in the neighborhood of $75,000. He said that ten men could be put on the work about June 1, and that after the completion of the appraisal of the Union Gas & Electric Company of Cincinnati the commission could add about twenty to the Cleveland valuation work.

Attorney Hogsett said that the Cleveland Electric Illuminating Company is anxious to have the appraisal completed, so that a proper rate for service may be made. The management is not satisfied to go through a long period of uncertain income and then end with a perplexing situation. It is under bond to return to patrons the amount collected above a flat 3-cent rate in case the city wins on the ordinance now before the Public Utilities Commission.

In the evening of March 31 the Cleveland men attended a hearing before the finance committee of the House of Representatives, in whose hands the proposal to reduce the appraisal force of the commission rests. General objection to the plan to reduce the force was expressed by company and municipal officials and representatives of the commission. The report that the commission had agreed with the efficiency department of the State Tax Commission in the proposed reduction was not borne out by the statements of Chief Engineer L. G. White, Counsel Lawrence K. Langdon and others. Mr. Langdon has stated that pending appraisals could not be completed in ten years, even if appropriations were made.

Messrs. Samuel Scovil, president of the Cleveland Electric Illuminating Company, Thomas Hogsett, attorney, and W. Kelsey Schoepf, president of the Cincinnati Traction Company, appeared before the finance committee to urge haste in completing the appraisals that have been begun and to argue against reduction in the number of men employed.

Vulcan Degree of the Jovian Order

The recently created Vulcan degree of the Jovian Order, to which Jovians in good standing will be eligible on payment of $10 annual dues in addition to the regular dues of $2 per year, was discussed by Mr. Homer E. Niesz before the Chicago Jovian League, on April 5. Since the establishment of the commercial division the national body has spent about $3 per member per year. and from dues it has received only $2 per member per year. The annual deficit of $1 per member has been made up from initiation fees. The Vulcan degree or "degree of industry" will support the commercial section. Were it not for the expenses of the commercial division the two-dollar dues would more than meet the expenses of the order, and for this reason, said Mr. Niesz, the officers deemed it unfair to increase dues. It is estimated that from $15,000 to $20,000 annually will be derived from dues of members of the Vulcan degree, because there are many Jovians to whom the commercial section is of direct benefit and it is expected that these men will consider the payment of the dues of the Vulcan degree a privilege. The idea of creating the new degree, said Jupiter Niesz, originated with Mr. S. A. Hobson, of the ELECTRICAL WORLD.

Federal Court Hears Springfield Rate Case

Judge Sanborn, presiding judge of the United States Circuit Court, of St. Paul, and Judge Van Valkenburgh, of Kansas City, heard arguments on April 3 at Kansas City, Mo., in the application of the Springfield (Mo.) Gas & Electric Company for an order restraining the Missouri Public Service Commission from enforcing its order establishing an 8-cent maximum rate for electrical energy in Springfield. The rate, under the commission order, was put into effect on July 1, 1914. The company includes on its bills notations as to the cost of service at 15 cents and at 8 cents per kw-hr. It has asked the court to allow the resumption of the old rates pending action by the courts and the commission. Under the federal law three judges must decide such cases. Judge Sanborn had appointed Judges Hook, Pollock and Van Valkenburgh. They heard arguments on Dec. 28, following which briefs were filed. Judge Hook withdrew on March 15, and Judge Sanborn completed the quota of judges. The arguments were repeated substantially as in December. Judge Pollock was not on the bench. Additional matter was then presented by Mr. John M. Olin, of Madison, Wis., counsel for the company, showing operating expenses and income during the entire period since the low rate went into effect. Further exhibits were made as to the hazard of transmission lines, including photographs indicating damage to the Kansas City, Clay County & St. Joseph Railway poles on Feb. 22, and similar destruction of the same nature in New England and other sections of the country. A telegram was presented declaring that the company could not sell sufficient securities to do needed work under present conditions in

Springfield and that the company's credit was ruined. Mr. E. C. McAfee, representing the people of Springfield, presented an advertisement made by the company at Springfield indicating a prosperous condition.

Judge Sanborn inquired as to the importance to the company of the steam-power plant which, it is claimed, is necessary as a reserve in case of failure of the supply of energy from outside points. Mr. McAfee was asked if the rates would be confiscatory in case the company's valuation of the power plant had been allowed. He responded that it was hard to answer, but probably they would be too low. Mr. H. T. Neville, also representing the people of Springfield, dissented from this opinion.

The court asked Mr. W. C. Busby, author of the commission law and general counsel for the commission, if an injunction should not be issued, despite any constitutional question, in case the rates were probably confiscatory. Mr. Busby responded that certainly no state had any right to confer on anybody the right to establish confiscatory rates; that the commission did not so contend; that it was seeking to be just to all parties, and that in the present instance it was depending on the justice of the order rather than on its authority to maintain an order.

In response to a question by Judge Van Valkenburgh, Mr. Busby said that the present law establishing the commission, even without a proposed explicit amendment to that effect which was not passed by the Legislature, required the commission to give a full hearing on all matters brought before it. The company contends that the commission considered testimony which it had no opportunity to answer. Mr. Neville dissented from Mr. Busby's answer as to the bearing of the constitutionality of the law on the present case, intimating that the commission orders should be final whether or not they contained errors.

No reason was given for Judge Hook's retirement from the case. The reason generally assigned is that his son is a member of a firm, Messrs. Bowersock, Hall & Hook, which represents the Kansas City, Clay County & St. Joseph Railway in another suit involving an order of the commission. Judge Hook has in hand the receivership matters of the Metropolitan Street Railway of Kansas City, in which are involved questions as to the relations of companies and the public, costs of operation and rates, that are concerned in the Springfield case.

Annual Report of Standard Gas & Electric Company

Mr. H. M. Byllesby discusses matters of general public interest in his annual report as president of the Standard Gas & Electric Company for the year 1914.

The increase in taxes for the three years ended Dec. 31, 1914, has been $360,855, and, while there is an inclination on the part of taxing bodies to treat companies more fairly, attention is called to the fact that taxes are still disproportionally high, being 14.4 per cent of aggregate net earnings. In addition to the taxes, companies are put to great expense in defending themselves before local taxing bodies and in efforts to obtain more equitable treatment. The effort mentioned in the previous report for fairer and less complicated state taxation laws, resulting in the assessment of taxes as a percentage of gross or net income, is meeting with a degree of success. Mr. Byllesby believes that there is evidence that eventually this reform will be accomplished.

The twelve months covered by the report include two distinct periods of conditions. From the beginning of 1914 to Aug. 1 a general, though slight, improvement in business conditions was in evidence. From Aug. 1 to the close of the year the general trend was somewhat difficult to determine owing to the effect of the European war.

In the case of the two California operating companies large gains have been made in gross and net income beginning about July 1, 1914, and continuing with gratifying regularity to the date of the report. In the Northern States Power Company an upward tendency has been marked from the beginning of 1914 and continues. In the Arkansas Valley Railway, Light & Power Company the gain became, it is believed, permanent with December, 1914.

The Louisville Gas & Electric Company suffered from general commercial depression which has been marked in all industries of that city. With completion of the consolidation of the numerous power houses, effective about Aug. 1, 1915, a large gain in net earnings will result. Mr. Byllesby looks forward to future operations of this company with marked confidence and believes that it will prove to be one of the most profitable assets of the Standard company.

Regarding the Northern Idaho & Montana Power Company, Tacoma Gas Company, and Everett Gas Company, Mr. Byllesby writes in effect: They operate in the Pacific Northwestern section, which has suffered great business depression for the last three years. When this section, possessing every conceivable natural resource, has a revival, which is bound to come, marked gain will result.

The Fort Smith Light & Traction Company, Mr. Byllesby says, has suffered from business depression. It is believed that revival will surely take place on account of wonderful natural resources and substantial population, but how long it will be deferred cannot be predicted.

The Northern States Power Company, with its subsidiaries, is developing rapidly. The territory is enjoying great prosperity, and the only limit to further development is that which may be prudent or of necessity prescribed by the supply of capital for enlargements and extensions.

In general, from an intimate knowledge of the properties and their surrounding conditions it is believed, Mr. Byllesby adds, that income of the Standard company is at its lowest point and that it will improve from this time. Decided improvement has taken place already in earning conditions of certain properties, and in others there are no conditions which would warrant apprehension of further diminution, while there is every reason to expect revival at some time. With only a comparatively reasonable improvement in earning condition of the properties which have been more or less stagnant for two or three years, the income of the Standard company will be far more than sufficient to provide for the normal 8 per cent preferred stock dividends in cash.

Directors continued the payment of preferred stock dividends of the Standard company in scrip. With the dividend of Dec. 1, 1914, the rate was reduced to 1 per cent per quarter from the 2 per cent per quarter theretofore paid. In view of the generally unsettled condition it was deemed the part of prudence and to the interest of shareholders to bring the dividend disbursement well within the collectible income. The company will continue retirement of the remaining collateral trust notes, and at a convenient period in the money market will undertake to make effective arrangements for money for capital expenditures of subsidiaries on a better basis. When this is accomplished the Standard company will return to a cash dividend basis, but it is not deemed prudent to restore cash dividends until future financial arrangements are completed definitely.

Miscellaneous News Notes

Illinois Civil Service Examinations.—Examinations will be held Saturday, May 1, by the Illinois State Civil Service Commission to fill two positions as utilities investigator and two as utilities rate expert for the State Public Utilities Commission of Illinois. Applications must be on file with the commission in Springfield before 5 p.m., April 24.

Museum of Safety Moves.—So that it will be nearer the working center of the city and consequently able to keep in closer touch with the workers, the American Museum of Safety has leased new quarters at 14 to 18 West Twenty-fourth Street, New York, and removed from the quarters which it occupied for many years in the Engineering Societies Building in that city.

Ohio Board Adopts A. S. M. E. Standards.—The Ohio Board of Boiler Rules at a meeting held March 25 adopted the following resolution: "Until further notice an inspector holding a certificate of competency and a commission authorizing him to inspect steam or hot-water boilers which are to be installed within the State of Ohio is hereby authorized to inspect during construction, and on completion stamp 'Ohio Std.' with serial number, any boiler constructed in accordance with rules formulated by the boiler code committee as submitted to the council of the American Society of Mechanical Engineers on Feb. 13, 1915."

Common Stock Issues.—The Railroad Commission of California, in authorizing debenture and stock issues of the Southern California Edison Company, made the following comments regarding common stock: "The common stocks of corporations which are available for public purchase are rarely, if ever, wholly investment securities, and this speculative aspect should be kept in mind by security holders in connection with any authorization which may be given by this commission with an issue of common stock. Of course, every security has its own speculative attribute, but this feature is more predominant than elsewhere in common-stock issues."

Precedent Established in Regard to Outages Caused by Fires.—It is customary for municipalities to deduct from the lighting company's bills a sufficient amount to cover the time that lamps are out as reported by the night police or watchmen. At Marshfield, Ore., however, the City Council refused to deduct anything from the bill of the Oregon Power Company because the lamps were out during two fires which occurred recently. The members of the Council took the position that fires were something over which the power company had no control and that lack of service so caused was no fault of the company, and they ordered the full amount of the bill to be paid.

Cincinnati to Enforce Court Order.—On March 30 the City Council of Cincinnati, Ohio, adopted a resolution instructing City Solicitor Schoenle and Director of Public Service Fosdick to enforce the mandate of the Ohio Supreme Court in reference to the Diamond Light Company by cutting its wires and preferring charges of contempt against its officials. In presenting the resolution Councilman Mullen said that the Council had asked the courts to restrain the company from operating without a franchise and that the two higher courts had sustained the claim that in order to use the streets and alleys a franchise must be secured. If the Council did not do something to stop operation, the suit might be held to have been brought in bad faith.

Minneapolis House-Wiring Statistics.—During the ten years ended with 1914 the estimated cost of the electrical equipment of consumers' premises, including wiring and fixtures, etc., in the city of Minneapolis amounted to $8,757,538. Owing to the growing use of electricity in homes and small business places, the total number of permits during 1914 showed a substantial increase over previous years, although the value of the work was somewhat less than in the four previous years. In 1905 3899 permits, whose aggregate value amounted to $374,744, were granted. This number increased to 8439 permits in 1914, with an aggregate value of $991,755. The largest aggregate estimated cost was in 1911, when 6605 permits were granted, the value of which was estimated at $1,548,525.

Power Commission Wants More Power.—The plans of the Hydro-Electric Power Commission of Ontario for securing an additional power supply will, it is understood, be completed by the middle of next summer. The commission is faced with the prospect of exhausting its present contract of 100,000 hp, and it is weighing the alternative propositions of purchasing additional power along the lines now followed or widening the policy of developing its own power as initiated with the Wasdell's Falls and Eugenia Falls plants. For nearly a year past the engineers of the commission, acting under the direction of Sir Adam Beck, have been at work on investigations and estimates for the development of power at the Niagara River and from the spillways of the Welland Canal. It is believed that both developments will be practicable.

Engineering and Warfare.—In connection with the movement undertaken by the Western Society of Engineers, Chicago, to enlist the interest of its members in a plan to instruct engineers engaged in civil practice in the principles of defensive warfare, should the nation ever need their services, an illustrated talk on "Engineering in Warfare" was given by Col. W. V. Judson, United States Army officer in charge of the port of Chicago, at the rooms of the society, on April 5. Colonel Judson related his own experiences as a military observer with the Russian army during the Russo-Japanese war. Mr. Taliaferro Milton discussed plans for organizing engineer corps. In a letter to the society the United States War College has offered to indicate a course of reading for the instruction of civilian engineers in the principles and equipment of modern warfare.

Reduction in Rates in New Albany, Ind.—A reduction of electrical energy rates in New Albany, Ind., has been made as a result of a compromise of cases before the Public Service Commission. An average cut of 9 per cent is to be made in charges. The United Gas & Electric Company, which serves both New Albany and Jeffersonville, buys most of its energy from the Louisville Gas & Electric Company. A number of New Albany residents had complained, and Commissioner Charles Murphy, of the Indiana commission, was about to begin a hearing when the compromise was effected. The reductions range from 16⅔ per cent for consumers of 10 kw-hr. to 7.4 per cent for consumers of 1000 kw-hr. per month and mean a loss in revenues to the company of about $8,700 on the basis of last year's consumption. The new rates for lighting service run from 10 cents per kw-hr. for the first 50 kw-hr. to 5½ cents for all over 150 kw-hr., while for motor service the rate runs from 8 cents per kw-hr. for the first 100 kw-hr. to 3 cents for all over 300 kw-hr. A 10 per cent discount applies on all bills paid within ten days.

Associations and Societies

Telegraph Superintendents.—The annual convention of the Association of Railway Telegraph Superintendents will be held at Rochester, N. Y., June 21 to 25. Mr. P. W. Drew, 112 West Adams Street, Chicago, is secretary.

New York Jovians.—Mr. Arthur Williams, general inspector New York Edison Company, was the chief speaker at a meeting of the New York Jovian Electrical League on April 7. In discussing the subject "It Pays to Advertise," Mr. Williams stated that the advertising bill for the whole country is about $700,000,000 per year, or about twice the total income of central stations throughout the United States. He said that the electrical interests spend much too small a percentage of their income for advertising, which always pays, although the returns are seldom directly traceable. On Wednesday, April 14, at 8 p.m., the league will hold a smoker at the Hotel Martinique.

Meeting of Pacific Coast Electrical Jobbers.—Electrical jobbers of the Pacific Coast met at Del Monte, Cal., on March 25 to 27. In addition to the many conferences and the large amount of time devoted to amusements, an open session was held on the afternoon of March 27. Difficulties in the business were discussed at this meeting. Mr. H. V. Carter was chairman. Among those who spoke were Messrs. W. S. Seaver, T. E. Bibbins, Garnett Young, T. C. Hillis, C. M. Parr, W. S. Berry, T. E. Burger, W. L. Goodwin, G. C. Holbertson and S. M. Kennedy. Mr. Kennedy expressed the opinion that central stations should devote their efforts to the sale of energy and should not sell lamps and appliances.

May Meeting of the Iron and Steel Engineers.—The Association of Iron & Steel Electrical Engineers will hold a meeting on Saturday, May 1, at the Seventh Avenue Hotel, Pittsburgh, at which Mr. R. S. Wile, president of the Wile Electric Furnace Company, will present a paper on the subject "The Electric Furnace and the Melting of Alloys." The meeting, which will begin at 8 p. m., will be preceded by a dinner at 6.30.

Association of Edison Purchasing Agents.—At a recent meeting in Buffalo, N. Y., of the Association of Edison Purchasing Agents the following officers were elected to serve one year: Mr. W. H. Francis, president, Edison Electrical Illuminating Company of Boston; Mr. Andrew Banks, first vice-president, Consolidated Gas, Electric Light & Power Company, Baltimore; Mr. J. W. Brennan, second vice-president, Edison Illuminating Company, Detroit; Mr. D. R. Blaicher, treasurer, Minneapolis General Electric Company; Mr. H. F. Frasse, secretary, Edison Electric Illuminating Company of Brooklyn.

Banquet of Columbus Edison Club.—The first annual banquet of the Columbus Edison Club, Columbus, Ohio, took place at the Elmont Restaurant on March 26, fifty-six members being present. The club is composed of employees of the Columbus Railway, Power & Light Company. General Superintendent H. W. Clapp described the progress of the company. When it first organized two generators of the 50-kw rating each were installed. At present the generators in operation have a rating of 20,000 kw. Other speakers were Mr. D. C. Edgar, general superintendent of the Tennessee Power Company; Prof. E. A. Hitchcock, formerly of the Ohio State University, and Mr. W. A. Wolls, of Columbus.

St. Louis Jovian League.—The St. Louis Jovian League of Electrical Interests now has nearly a thousand members and claims to be the largest local electrical organization in the world. Luncheons are held every Tuesday at the American Hotel Annex, St. Louis, followed by talks on electrical topics. Mr. A. R. Fairchild, of the Union Electric Light & Power Company, St. Louis, was the speaker for the meeting of April 6, with an illustrated lecture on "Hydroelectric Development on the Pacific Coast." Mr. F. D. Beardslee, of the Union Company, is president of the club, Mr. Fred Johnson, of the Wagner Electric Manufacturing Company, is vice-president, and Mr. F. D. Phillips, of the Wesco Supply Company, is secretary-treasurer.

Health and Light.—The value of sunlight as a germicidal agent was emphasized by Dr. W. A. Evans, former health commissioner of the city of Chicago, in a talk before the Chicago Electric Club, April 1, when he pointed out the improved public health to be expected from such conditions of clear atmosphere over cities as would result were all power generated in great central stations and all railroad terminals electrified. Direct sunlight, asserted the speaker, will kill tuberculosis germs in sputum in seven minutes' exposure, whereas corrosive sublimate, ordinarily considered a powerful germicide, would be rendered quite innocuous by the secretions in the sputum. Ordinary diffused light from the sky contains enough ultra-violet rays to kill such tuberculosis bacteria in a few hours, although these bacteria remain active and multiply with much rapidity in the dark.

Efficiency Society of America.—The Efficiency Society of America was incorporated at Columbus, Ohio, on April 2, 1915, by Messrs. G. E. Burroughs, L. B. Passmore, Grover Schaible, Anthony M. Golubich and H. B. Frazier, of Pittsburgh, Pa., and Cleveland, Ohio, in behalf of a charter membership association of some 1500 technical and commercial men resident throughout Canada, the United States, Mexico and South America. The objects for which the society has been formed are "to discuss and promote questions relating to administrative, productive and commercial efficiency and to promote questions relating to domestic and foreign trade with special reference to trade expansion and engineering construction opportunities for the individual technical business man." A free information and statistical exchange will be instituted for the use of professional men. The society will publish a monthly and weekly journal, the first issue to appear May 1. Mr. G. E. Burroughs, Fulton Building, Pittsburgh, Pa., is chairman of the organization committee.

Public Service Commission News

Wyoming Commission

The commission has been organized. It is composed of Governor John B. Kendrick, State Auditor Robert B. Forsyth and State Treasurer H. B. Gates. Mr. H. Allen Floyd has been appointed secretary.

Idaho Commission

Mr. E. G. Gallet, secretary of the commission, writes that no uniform electrical rates have been adopted as reported in the Electrical World of March 27, 1915, and that it would be a practical impossibility under the conditions prevailing to establish any such rates.

California Commission

Of the $226,725,502 securities whose issue was authorized by the commission during 1914, $48,469,780, or 21.38 per cent, were for gas and electric companies, and $182,345, or 0.80 per cent, for telephone and telegraph companies. The larger proportion, $138,744,183, or 61.20 per cent, were for steam railroads. The purposes for which the total securities were authorized were: New construction, 57.85 per cent; refunding, 37.01 per cent; collateral, 3.96 per cent; miscellaneous, 1.18 per cent.

Ohio Commission

The Reighard bill, making the physical appraisal of public utility properties by the commission optional instead of mandatory, as at present, was passed by the House of Representatives on April 1 by a vote of eighty-two to nineteen. In upholding the bill, Minority Leader Kramer said that councils do not hesitate to demand appraisals of properties at any time, because the State and the utility corporations must pay the expenses. Representative Young of Cleveland opposed the bill on the ground that valuations are absolutely necessary for rate-making. He argued that the mandatory feature be preserved as far as local appraisals are concerned, although the commission might use its discretion in ordering railroad appraisals.

The Behne bill, defeated in the Senate on March 30, was reconsidered on April 1 and made a special order for a later day. Opponents of the bill declare that it will discourage municipal ownership, because it will virtually cause publicly owned properties to carry their own financial burdens directly, instead of permitting bonds representing the cost to be merged with other indebtedness.

Indiana Commission

The commission has approved the sale of the Indiana properties of the Cumberland Telephone & Telegraph Company of Atlanta, Ga., to the Southern Indiana Telephone Company. The Cumberland company valued the property concerned at $2,050,000. The commission did not allow this valuation to stand, and the agreed total was about $1,790,000. A rate-making case, involving the Cumberland properties, has been before the commission for months. A compromise, whereby alleged discrimination will be abolished without the loss of revenue by the company, has been under consideration.

The commission is gratified over the termination of the Evansville gas tangle, which threatened a long legal contest over the constitutionality of the commission law, and particularly the rate-making power of the commission. The Evansville Public Service Company, as stated in the Electrical World of April 3, 1915, brought suit against the commission because of an order establishing a maximum rate of 85 cents per 1000 cu. ft. for gas in Evansville. The commission had made arrangements to contest the suit, when a compromise was reached whereby the utility paid approximately $10,000 of costs for the city of Evansville and the commission and agreed to accept the 85-cent rate, with no right of appeal for two years. In return the commission annulled its former order, thereby withdrawing the legal valuation of the property which it had made. A valuation of $750,000 for rate-making purposes had been fixed by the commission. The withdrawal of this valuation left the company free to negotiate the sale of securities. The agreement did not abridge the right of consumers to appeal

from the schedule, of which the 85-cent maximum rate was the principal part.

The commission has ratified a schedule of electric rates accepted by the city of Oakland City and the Oakland City Electric Light & Power Company. The schedule provides for commercial rates from 6½ cents to 10 cents per kw-hr. and for motor-service rates from 3½ to 7½ cents per kw-hr., with a 50-cent minimum rate and one-half of 1 per cent discount for prompt payment. The yearly rate for municipal lighting is to range from $15 for 60-watt lamps to $50 for 250-watt lamps.

Wisconsin Commission

The application of the Brodhead municipal electric-light plant for an increase in revenues has been granted by the commission. In determining the cost of service to be used as a basis for rates, the commission disallowed certain expenditures which were the results of casualties and accidents, holding that these contingent expenditures should have been provided for by proper insurance and that consumers could not be penalized for lack of foresight in the management by being forced to pay increased rates. Special motor-service rates hitherto granted to a few large consumers were ordered discontinued, and all consumers are to be placed on the same schedule.

A bill has been introduced in the Assembly giving the commission authority to regulate interferences with telephone or telegraph service resulting from electric-energy transmission lines, whether the interference be due to electromagnetic induction, electrostatic induction or to leakage. The bill also gives the commission authority to regulate construction of high-tension electric transmission lines so as to make them safe, to require changes in construction and methods of operation wherever public safety requires such changes, and to fix the proportion of the cost and expense of such changes to be borne by each party.

New Hampshire Commission

The biennial report of the commission says in part:

"There is no possible question that the administration of the public service act has resulted in direct financial benefits to the public far outweighing its expense. But the direct financial benefits accruing from the administration of the act are almost inconsequential in comparison with the gain to the State from improved conditions not capable of measurement by the standard of dollars and cents. But the chief gain to the State from the administration of the act is not to be found in pointing to specific things done by the commission. It lies rather in the assurance that the aphorism that 'for every wrong there is a remedy' is not a mere statement of an abstract principle, but, so far as the relations of the public service corporations of New Hampshire to the public are concerned, is an accomplished fact.

"Not every person deeming himself aggrieved by the action of such a corporation is satisfied with the commission's decision on his case. It is impossible that every decision should be correct and do full justice to all the parties. But every person receiving or desiring the service of any railroad or public utility can now know that if he regards himself as failing in any respect to receive fair and reasonable treatment, he is no longer obliged helplessly to submit, but has a tribunal to which he can appeal with the assurance that, whatever the limitations of its judgment and abilities, it has at least the power and the disposition to secure for him his just rights. The value of the commission system of regulation can no more be estimated on the basis of its pecuniary saving to the State than can the value of our courts or our schools.

"We have not the requisite apparatus for making the tests of electric services, and no routine service inspections have been made under the rules. Two electric meters have been tested at the request of the consumers. One was found to be correct and the other 100 per cent fast, and in the latter case, under the rules established by the commission, the refund amounted to $300.

"It is known that many of the different rate schedules in force, by discount provisions which give a constantly decreasing rate according to the increased quantity of service taken, and which are not scientifically drawn, violate the fundamental principle of fairness, that the charge for any quantity of service shall not exceed the charge for a larger quantity of service of the same kind. The actual discriminations arising from unscientific schedules of this character are not, however, very serious. The rates of electric utilities are most striking in variety of form and in range of prices charged for the same class of service by different companies. Schedules of utilities in general disclose many discriminatory features which ought to be easily eliminated by co-operation between the utilities and the commission. Such attention as our more imperative duties have permitted has been given to this matter, but much important work remains to be done.

"If the Legislature should provide for the payment of the expenses of this department by a special tax upon the utilities supervised, we recommend that the salaries of the commissioners be not included in the expenses so levied."

New York Commissions

The Second District commission has settled the Westchester Lighting Company rate cases. Stipulations accepting the settlement have been filed by the company and complaining communities. Rate reductions are to be made, effective on May 1. The company is given permission to maintain a minimum rate of $1 per month for electric energy as no testimony had been presented on that subject. The maximum rate for electrical energy will be reduced to 12 cents per kw-hr. in the districts from which complaints were made. The reduction applies also to districts in Mount Vernon and New Rochelle from which new complaints had been presented. The rate for gas for illuminating purposes will be reduced in Port Chester, Tarrytown and White Plains. The new rate for electrical energy is to be continued for at least three years. The maximum rate for gas during this period in the communities concerned in the settlement will be $1.25 per 1000 cu. ft.

The order of the Second District commission reducing New York Telephone Company rates in New York City, effective on July 1, has been accepted by the company. Mr. John L. Swayze, attorney for the company, in a statement accepting the order, says: "The company believes that the condition of unrest and disturbance which has existed for the last two years will cease, and from now on the company will be permitted to devote all its energies to developing its business and providing the public with telephone service and facilities. The company believes that the cordial and pleasant relations which have always existed between the company, its patrons and the general public will continue, and the company will devote every effort toward meriting the continuance of such relations."

In its order the commission states the value of the property of the company in New York City for rate-making purposes in this case at this time at $82,000,000, to which is to be added the cost of property improvements between June 30, 1914, and July 31, 1914, $1,796,685. The company is entitled on present consideration to a return of 8 per cent upon that value. There shall be allowed as reduction from telephone operating revenue for reduced rates ordered by the commission $3,000,000, and the 8 per cent return is allowed upon consideration that the operating income from the New York City property for the year ended Dec. 31, 1914, after deducting all proper expenses, taxes, rents and other proper charges, shall be taken as at least $10,027,445. The return is also based upon consideration of the company's 8 per cent dividends and surplus account, the fact that New York City, by reason of its larger and dense population, constitutes the company's most profitable field of operation, and the further fact that the long-distance service as maintained has a special value to subscribers and the public generally. The commission has estimated that the proposed schedule, after further changes, will cause a present reduction in revenue of $2,943,000, thus leaving a balance of $57,000 to cover omissions and errors and making a total present reduction of $3,000,000 over and above the 10 per cent reduction made by the company during the pendency of the proceedings, estimated by the company at over $2,000,000.

Governor Whitman notified Commissioners McCall, Cram, Williams and Wood that he would not expect them to appear before him on April 6, the date to which the hearing on the charges against them was adjourned.

Personal

Mr. J. J. Matthias, of Burlington, Vt., has been appointed local manager of the Leominster (Mass.) Electric Light & Power Company vice Mr. R. Y. Conklin, transferred.

Mr. B. S. Waters, manager of the South Bend property of the Northern Indiana Gas & Electric Company, has been transferred to Hammond to succeed Mr. W. R. Ray, resigned.

Mr. C. N. Chubb, vice-president and general manager of the Michigan City (Ind.) plant of the Northern Indiana Gas & Electric Company, has been transferred to the Geist property at South Bend.

Mr. R. Y. Conklin, who has been local manager of the Leominster (Mass.) Electric Light & Power Company, has resigned to assume charge of the gas plant at Arlington owned by the same interests.

Mr. H. V. Armstrong, superintendent of the Northern Indiana Gas & Electric Company at Michigan City, Ind., has been appointed manager of the property, vice Mr. C. N. Chubb, transferred to South Bend.

Mr. Edward N. Hurley, who was recently appointed vice-chairman of the federal trade commission, was the guest of honor at a dinner given by the Illinois Manufacturers' Association at the Hotel Congress, Chicago, April 8.

Mr. Eliot Wadsworth, of the firm of Stone & Webster, Boston, Mass., sailed from New York on March 20 on the American Line steamer *St. Louis* to take up work in Berlin for Polish relief under the auspices of the Rockefeller Foundation.

Mr. S. P. Southard has been appointed manager of the Albuquerque (N. M.) Gas, Electric Light & Power Company, one of the properties of the Federal Light & Traction Company, New York. Mr. Southard, who was formerly manager of the Las Vegas Light & Power Company, succeeds Mr. A. F. Van Deinse.

Mr. B. T. Burt, recently general manager of the Chattanooga & Tennessee River Power Company, has joined the organization of W. S. Barstow & Company, Inc., New York, as operating manager in charge of several of the properties of the General Gas & Electric Company, which has recently taken over the properties of the Atlantic Gas & Electric Company.

Mr. A. F. Van Deinse, for many years manager of the Albuquerque (N. M.) Gas, Electric Light & Power Company and vice-president of the New Mexico Electrical Association, recently organized, has been transferred to Springfield, Mo., where he will take charge of the Springfield Gas & Electric Company, which is controlled by the Federal Light & Traction Company.

Mr. Frank M. Tait, president of the Dayton (Ohio) Power & Light Company, will remove to New York about July 1 to become closely identified with the Brady interests at 54 Wall Street. Mr. Tait is a former president of the National Electric Light Association and the Ohio Electric Light Association and is widely known as an operator of public utility properties. He will retain his interests in the Dayton Power & Light Company and continue as its president.

Obituary

Arthur L. Kelley, until recently president of the Narragansett Electric Lighting Company, Providence, R. I., died at his home in Providence on April 7, in his fifty-seventh year. He was a native of Canton, N. Y., and was educated at Lawrence, Mass., and at Phillips Andover Academy.

George Cutter, one of the veterans of the electrical industry and formerly a prominent figure at meetings of electrical societies, died of heart failure April 6, at the California Hospital, Los Angeles, Cal., where he had been confined for six weeks. He is survived by his widow, who was with him in California. At the time of his death Mr. Cutter retained the office of vice-president of the George Cutter Company of South Bend, Ind., which he accepted at the time of the latter company's amalgamation with the J. Lang Electric Company of Chicago, in 1912. In recent years, however, Mr. Cutter had largely retired from business cares. He was born near Boston in 1853, and began his electrical work in 1869.

Corporate and Financial

Alabama Power Company, Birmingham, Ala.—The following companies have been merged with the Alabama Power Company: Alabama Electric Company, Wetumpeka Power Company, Alabama Power & Electric Company, Alabama Power Development Company, Anniston Electric & Gas Company, Huntsville Railway, Light & Power Company, Decatur Light, Power & Fuel Company, Eutaw Light & Power Company and Pell City Light & Power Company. They have been controlled for some time but have been operated separately. Since the opening of Lock 12 they have been fed from the Alabama Power hydroelectric system, using their steam plants as reserves. The consolidation was made in the interest of greater economy and efficiency. In connection with the merger the company sold $2,000,000 three-year first mortgage 6 per cent bonds on Feb. 1, 1915. As a result of the merger Mr. Frank S. Washburn, formerly president, becomes chairman of the board, and Mr. James Mitchell, formerly a vice-president, becomes president.

Canadian Westinghouse Company, Ltd.—The curtailment of business activity throughout Canada, according to the annual report for the year ended Dec. 31, 1914, which made itself apparent in the latter months of 1913, became more pronounced during the year just closed. With industry and commerce approaching stagnation, the European war suddenly became a factor to be reckoned with, and the business of the company, depending largely on the ability of corporations and communities to promote plant extensions of one kind or another, suffered a recession both unjust and severe. The almost complete retirement of railways from the purchasing field was the individual feature most notable because of its far-reaching effect on practically every branch of the industry. The policy uniformly followed of providing for periods of business depression by making liberal depreciation allowances and creating substantial reserves from profitable operations in times of prosperity places the company, the report states, in a position to meet with entire confidence the unusual conditions now prevailing until such time as its temporarily reduced earning capacity can be restored by the return of normal activity. The profit and loss account shows:

Net earnings	$386,113
Deduct:	
Dividends	359,489
Bank interest	5,625
Balance	$30,999
Surplus balance Jan. 1, 1914	1,531,491
Surplus Jan. 1, 1915	$1,562,490

Coast Valleys Gas & Electric Company, San Francisco, Cal.—The California Railroad Commission has authorized the company to issue $10,000 bonds. Originally the company was authorized to issue $100,000 of bonds on Dec. 4, 1914, but the authority was withdrawn subsequently pending an investigation into the company's liability in connection with a guarantee upon the bonds of the Monterey & Pacific Grove Railway, whose stock is owned by the Valleys Gas & Electric Company. The railway company has an authorized bond issue of $300,000 of thirty-year 6 per cent bonds, which were guaranteed at the time of issue by the Monterey County Gas & Electric Company. This company was sold in 1911 to Mr. F. G. Baum, and by him transferred to the California Consolidated Light & Power Company, from which the property passed to Mr. L. H. Rich, and from him to the Coast Valleys Gas & Electric Company. At the hearings before the commission the Coast Valleys Gas & Electric Company maintained that the guarantee upon the bonds had not passed to it, but had either been assumed by one of the parties in ownership which had intervened between the Monterey County Gas & Electric Company and the Coast Valley Gas & Electric Company or had not passed from the original guarantor. The commission takes the position in its decision that it has not the power to adjudicate the question of the company's liability in connection with the guarantee upon the railway company's bonds. It does take the position that the Coast Valley Gas & Electric Company should not be authorized to increase its bonded indebtedness in any way that would be prejudicial to the rights of bondholders of the railway company. The company's application as regards the issuance of $90,000 bonds was therefore de-

nied, but permission was granted to issue $10,000 bonds for extensions in the vicinity of Kings City, which it was shown were to the immediate interest of the company and its consumers.

Colorado Power Company, Denver, Col.—The report for the year ended Dec. 31, 1914, states that customers secured in 1914, less the customers lost, will, it is estimated, contribute $70,000 additional gross revenue during 1915, which, together with business in hand or in sight, compensates for the reduction in revenue to occur late in 1915 from changes in rate in certain wholesale business. Early in 1915 the Salida (Col.) Light, Power & Utility Company and the Mutual Electric Light & Power Company of Alamosa, Col., were merged with the company. Instead of making extensive repairs to the worn running parts of the Shoshone turbines, it has been decided to install new running parts and take advantage of the greatly increased efficiency obtainable from improvements in turbine design since the original units were installed. This will be done during the present year and the cost met out of depreciation reserve. Partly as a result of exercising rights under certain low-price wholesale contracts by withdrawing energy for re-sale at retail prices, retail revenue has increased about $90,000 during 1914, while the wholesale revenue has decreased about $30,000. It is stated that a continuance of this practice will insure further increases in revenue long after the generating plants are fully loaded. The following comparative statement shows the results of operation of the company and predecessor companies with inter-company charges eliminated:

	1914	1913
Gross operating revenue	$746,869	$692,585
Operating expenses	197,157	184,961
Reserve taxes	71,000	44,325
Total operating expenses	$268,157	$229,286
Net operating revenue	$478,712	$463,299
Other income	29,678	19,980
Total corporate income	$508,390	$483,279

Edison Electric Illuminating Company of Brooklyn, N. Y.—The company's comparative statement for 1913 and 1914 as filed with the New York Public Service Commission, First District, follows:

	1914	1913
Operating revenue	$6,244,385	$5,655,200
Operating expenses	3,709,286	3,204,836
Taxes	441,692	428,462
Uncollectible bills	16,875	14,062
Operating income	$2,076,532	$2,007,840
Non-operating income	25,822	25,385
Gross corporate income	$2,102,354	$2,033,225
Income deductions	2,028,537	1,961,527
Net corporate income	$73,817	$71,698
Additions to surplus	20,225	34,530
Deductions from surplus	$90,042	$106,228

Flatbush Gas Company, Brooklyn, N. Y.—The comparative statement for 1914 and 1913 of the company, filed with the New York Public Service Commission, First District, follows:

	1914	1913
Electrical department:		
Operating revenue	$414,232	$367,592
Operating expenses	346,835	310,624
Taxes	15,806	14,819
Uncollectible bills	415	1,368
Total	$51,176	$40,771
Gas department.		
Operating loss	87,021	100,775
Operating loss of gas and electric departments	$35,845	$60,004
Non-operating income	2,133	3,382
Gross corporate loss	$33,712	$56,622
Income deductions	95,714	91,730
Net corporate loss	$129,426	$148,352
Previous deficit	327,133	184,447
Surplus adjustments, net charge	5,335	*4,666
Deficit at close of year	$461,894	$327,133

*Surplus.

Gary (Ind.) Heat, Light & Water Company.—In connection with the surrender of its franchise for operating in Gary and the acceptance of an indeterminate permit from the Public Service Commission, Mr. L. W. McNamee, president and treasurer of the company, writes: "Inasmuch as it is undoubtedly the theory of the law that it is to the interest of the public that a utility company should submit itself freely to the advice and control of the commission, it is the desire of the company to conform to the policy of the laws of the State, to submit services which it is furnishing to the approval of the officers of the State selected for that purpose. Our action in surrendering our franchises and taking an indeterminate permit in lieu thereof from the commission evidences our desire to comply with the public policy of the State as manifested in the passing of this law establishing the Public Service Commission."

Marconi Wireless Telegraph Company of America, New York, N. Y.—A preliminary report for the year ended Dec. 31, 1914, does not include details affecting transoceanic high-energy stations, the operation of which was to have been begun when the European war was declared. The war has interfered with and will continue to interfere with the transatlantic service and to a considerable extent with the transpacific service. A summary for the year showed:

Gross earnings from operation	$756,573
Operating and administration expenses	634,958
Net earnings from operations	$121,615
Income from investment of surplus funds	150,274
Net income for year before charging reserves	$271,889
Reserves:	
Depreciation of coast stations	$30,038
Depreciation of ship stations	29,474
Against expiration of patents	50,000
For contingencies	12,500
Net income for year after charging reserves	$149,877

Niagara, Lockport & Ontario Power Company, Buffalo, N. Y.—The growth of output, according to the annual report for the year ended Dec. 31, 1914, has been from 96.575,110 kw-hr. delivered in 1908 to 244,651,276 kw-hr. in 1914. In the same time receipts have grown from $592,103 to $1,557,124. The Salmon River plant, which is about 42 miles north of Syracuse, has been in operation since April, 1914, and the full capacity has been available since Dec. 1, 1914. Since energy from this source has become available it has been possible to operate the steam plants at Lyons and Auburn at much less expense. The saving over 1913 on this account was upward of $25,000, and it is anticipated that in 1915 the cost of operating the steam plants will be reduced still further so that the total saving will be more than $40,000 per annum. The income statement for 1914 follows:

Sales of energy		$1,403,574
Cost of energy:		
Purchased	$539,905	
Produced (including $7,444 for depreciation)	$1,034	602,939
Gross profit from sales of energy		$782,635
Operating expenses (including $18,259 for depreciation)		173,189
Net earnings		$609,446
Other income		153,550
Gross income		$762,996
Deductions from income (taxes, rents, etc.)		239,985
Net income applicable to interest		$523,011
Interest		345,393
Net income before deducting sinking-fund payments.		$177,618
Sinking-fund payments		67,727
Surplus after deducting sinking-fund payments		$109,891
Surplus at beginning of year		183,045
Discount on company's bonds purchased for sinking fund		11,120
Discount on two-year 6 per cent secured gold notes charged to Erie Construction Company		40,000
Adjustment of consumers' bills applicable to prior period		4,078
Sinking fund reserves		63,488
Total		$411,622
Debits:		
Dividends	$162,000	
Discount on two-year, 6 per cent secured gold notes	40,000	
Miscellaneous	6,468	
Total		208,468
Surplus, Dec. 31, 1914		$203,154

Northern California Power Company, San Francisco, Cal.—In the annual report for the year ended Dec. 31, 1914, Mr. Edward Whaley, secretary of the company, offered the following reasons for the decrease in gross revenue: The largest decrease was from energy sold to the Pacific Gas & Electric Company. In 1913 the season was unusually dry, and as a result the Pacific company used much more energy than was called for in the contract. In 1914, however, with the aid of new developments, the Pacific company was well able to take care of its increased demand. The decrease

in irrigation load was caused by the comparatively great rainfall and also by the decreased operations of two large companies owing to financial difficulties. A loss was also shown for income derived from mining operations and commercial energy, which can be directly traced to the war curtailment and depression. A comparative statement of the company's earnings for 1913 and 1914 follows:

	1914	1913
Gross earnings from operation	$771,186	$824,494
Operating expense	$235,285	$230,322
Maintenance expense	78,345	45,162
Total	313,630	275,484
Net earnings from operation	$457,556	$549,010
Maintenance and depreciation reserve	32,817	74,219
Amortization of debt discount and expense	1,011	1,361
Net earnings	$423,728	$473,430
Miscellaneous revenue	7,654	6,076
Total	$431,382	$479,506
Doubtful accounts written off	8,905	4,144
Undistributed adjustments	1,050	27,205
Balance	$421,427	$502,567
Interest on bonds, debentures and floating debt	363,999	351,586
Surplus for year	$57,428	$150,981
Surplus end of previous year	587,090	444,718
Surplus end of year before correction	$644,518	$595,699
Surplus transferred	161,194	.....
Balance	$483,324	$595,699
Miscellaneous additions to surplus	144	1,222
Total	$483,468	$596,821
Miscellaneonus deductions from surplus	20,333	9,731
Balance	$463,135	$587,090

Northern States Power Company, Chicago, Ill.—In his annual report to stockholders for the year ended Dec. 31, 1914, Mr. H. M. Byllesby, the president, states that the business has been generally expanded and that there is a wide and satisfactory field developing continually for future operations. It is probable that during the coming year extensive enlargements to generating plants, both steam and hydraulic, and to the distribution systems will be undertaken in order to serve the business. Lrage contracts have been made recently which have not as yet come into the operation. At a suitable period steps will be taken to consolidate future financing. The combined earnings statement of the company and subsidiaries follows:

Gross earnings	$4,395,869
Operating expenses	2,031,499
Net earnings from operation	$2,364,370
Interest	1,339,668
Net income for year	$1,024,702
Preferred dividends, Northern States Power Company	587,069
Surplus for year	$437,633
Reserved for depreciation	128,000
Amortization of bond discount	45,000
Transferred to surplus	$264,633

United Gas & Electric Corporation, New York, N. Y.—In the annual report for the year ended Dec. 31, 1914, it is stated that the corporation had on hand on April 1 about $650,000 cash, but the uncertain outlook in the business and financial world and the extreme importance of conserving cash resources, in order that it might be in a strong position and able to render financial assistance, should any be necessary, to subsidiary companies convinced the directors that the wisest course required that no action on dividends be taken at present. During the year approximately $2,792,000 was expended for additions, betterments and extensions in the different departments. Operations of subsidiary companies for 1913 and 1914 showed:

	1914	1913
Gross earnings	$14,013,353	$13,628,343
Operating expenses	6,083,161	5,972,889
Net operating income	$7,930,192	$7,655,454
Other operating expenses:		
Maintenance	$1,268,075	$1,263,346
Taxes	794,148	709,615
Total	$2,062,223	$1,972,961
Gross corporate income	$5,867,969	$5,682,493
Fixed charges	3,459,237	3,308,261
Balance	$2,408,732	$2,374,232
Renewal and replacement reserve	486,827	387,700
Surplus applicable for dividends	$1,921,905	$1,986,532
Surplus at close of year	$4,688,066	$4,041,331

Manufacturing and Industrial

The Mackinnon Lumber & Pole Company, of Calgary, Alberta, Canada, has opened a sales office at 1632 Lumber Exchange Building, Chicago, which will be in charge of Mr. A. W. Mackinnon. The company makes a specialty of selling poles.

The Despatch Manufacturing Company, of Minneapolis, Minn., and Mr. G. H. Otto, of Chicago, have entered into an agreement by which Mr. Otto will handle the sales of Despatch electric ovens and heating appliances in Chicago. Mr. Otto's offices are at 72 West Adams Street.

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has opened a department for automobile equipment at 2025 Euclid Avenue, Cleveland, Ohio. The company will make a specialty of its motor-generator set, which has been developed for the Ford machine. Mr. S. L. Blackburn is district manager for the company, with headquarters in Cleveland.

The Hyatt Roller Bearing Company, Newark, N. J., has appointed Mr. P. B. Liebermann as its engineer of tests. Mr. Liebermann was graduated from the Royal Technical Institute, Charlottenburg, Berlin, in 1897, and formerly held responsible positions with the Allgemeine-Elecktricitäts Gesellschaft at Berlin, the Sprague Electric Company, New York, and the Electro-Dynamic Company, Bayonne, N. J.

New Department for Manufacturing Rubber Goods.—The Standard Woven Fabric Company, Framingham, Mass., has organized a new department for manufacturing rubber goods. At the start the company will specialize on friction tapes and splicing compounds for electrical purposes. Mr. F. J. Gleason, formerly of the Walpole Tire & Rubber Company and founder of the Massachusetts Chemical Company, has been engaged to take charge of the new department. During the past six months the Standard Woven Fabric Company has been very busy and its plant has been operating day and night during that time. The company has recently opened a new office at 1779 Broadway, New York, which will be in charge of Mr. C. O. Anthony. The company is planning an active selling campaign to push not only its rubber goods but also the "Multibestos" and friction materials which are made by it.

Steam-Turbine Company Busy.—According to the Terry Steam Turbine Company, Hartford, Conn., the amount of business secured thus far this year is in excess of that obtained during the same period of last year. Mr. Snow, general sales manager of the Terry Steam Turbine Company, has just returned from a six weeks' trip to the East and Middle West, and he states that he expects a considerable improvement during the next few months. The Western and Pittsburgh territories are showing increased activity, and it seems that they are recovering more rapidly from the recent depression than is the East. At the present time, Mr. Snow declares, business in Canada is very dull and no improvement can be looked for immediately. The Terry Steam Turbine Company has recently built twenty 60-hp turbines for the Philadelphia Electric Company for use with forced-draft blowers in its new Christian Street station. It has also just built four vertical turbines which will be used for forced-draft work on torpedo-boat destroyers.

The Western Electric Company recently moved from its old quarters at 611 Wyandotte Street, Kansas City, Mo., to new quarters across the street. The moving of its large stock and office equipment was accomplished without interruption to business and was done at night and on Sundays, two weeks being taken to complete the operation. A two-track runway was utilized which had to be removed every fifteen minutes to allow street cars and other vehicles to pass. There are 52,000 sq. ft. of floor space in the new building, which fronts on Central Street and Wyandotte Street. It covers an area 50 ft. by 170 ft. and has six floors. The basement and sub-basement are utilized for boilers and heavy hardware; the first floor fronting Wyandotte Street for city counter and display purposes, and fronting Central Street for fast-moving standard package stock, iron conduit, and the shipping, receiving and retail-distribution departments; the second floor for offices; the third floor for broken-package stock; the fourth floor for standard-package stock, and the fifth floor for shop and returned goods.

The Davison-Namack Engine Corporation, Ballston Spa, N. Y., has recently been formed and purposes to manufacture stationary internal-combustion engines under the patent of Lucien Foster, of Norwich, N. Y. The company will make a specialty of building units for electric-lighting outfits and for contractors. Mr. S. I. Foster is president of the company, Mr. G. W. Donnan vice-president, and Mr. R. H. Davison secretary and treasurer. The above-named officers and Mr. W. H. Namack form the board of directors. Mr. Foster is a civil engineer and has for several years been a general contractor on water-works and other similar operations. Mr. Donnan is an attorney in Schenectady. Mr. Davison is president and treasurer and Mr. Namack is vice-president of the Davison-Namack Foundry Company.

The Baker-Joslyn Company, which has recently been incorporated, opened offices and a warehouse at 71 New Montgomery Street, San Francisco, Cal., April 1, and is now acting as distributer of electrical material. The new company has taken over the electrical products of the Maydwell Company of San Francisco. Mr. M. L. Joslyn is president of the company, Mr. C. G. A. Baker vice-president and treasurer, and Mr. H. F. Hartzell secretary. Mr. Joslyn is president of the Joslyn Manufacturing & Supply Company of Chicago. Mr. Baker has been associated for many years with the Maydwell Company as vice-president and has been in charge of the electrical branches of the business. He will be in full management of the business operations of the Baker-Joslyn Company. Mr. Hartzell has been on the sales force of the Maydwell Company for the past two years and will occupy a position in the sales department of the new company similar to that he had in the Maydwell Company. The Baker-Joslyn Company will represent not only the manufacturers of electrical material formerly represented by the Maydwell Company, but several new manufacturers as well. Branches will also be maintained at Seattle and Los Angeles.

Order for Water Strainers.—Three 30-in. multiple water strainers were recently shipped to the Duquesne Light Company, Pittsburgh, Pa. Five of these strainers have already been installed by the above concern, and with the latest addition the company will have a total of eight 30-in. strainers. The strainers are of the multiple straining-basket type, each having five baskets, and four baskets are always in operation. With all five baskets in operation, the effective straining area, it is declared, is over three and one-third times that of the inlet or pipe line in which the strainer is installed; with one basket held in reserve or removed for cleaning purposes, the straining area of the four baskets is over two and one-half times the area of the pipe section. The baskets can be removed for cleansing purposes by operating a hand wheel which raises the basket into the cleaning chamber. The cover is then removed by loosening three bolts, and the basket is lifted out in an upright position. One 6-in. strainer, one 12-in. strainer and one 14-in. strainer have also been installed in the Rankin station of the Duquesne Light Company. The strainers were built by the Lagonda Manufacturing Company, Springfield, Ohio.

NEW YORK METAL MARKET PRICES

	March 30 Selling Prices Bid	March 30 Selling Prices Asked	April 6 Selling Prices Bid	April 6 Selling Prices Asked
Copper:	£ s d		£ s d	
London, standard spot*	69 0 0		69 17 6	
Prime Lake	16.25		16.50	
Electrolytic	15.70		15.80	
Casting	15.00		15.50	
Copper wire base	16.75		17.00	
Lead	4.15		4.20	
Nickel	42.00 to 45.00		42.00 to 45.00	
Spelter	9.62½†		9.75†	
Straits tin	53.00†		47.50†	
Aluminum, 98 to 99 per cent	18.75		18.75	

*OLD METALS

Heavy copper and wire	13.50	13.85
Brass, heavy	9.25	9.37½
Brass, light	7.75	8.00
Lead, heavy	3.95	3.95
Zinc, scrap	7.50	7.25

COPPER EXPORTS

Total tons to April 6	1,311

*From daily transactions on the New York Metal Exchange.
†Nominal.

New Incorporations

The Nairn Falls Power & Pulp Company, of Malbaie, Ont., Can., has been chartered with a capital stock of $100,000 by L. A. Martin, R. Pepin and L. E. Morin.

The Gate Electric Light & Power Company, of Jennings, Okla., has been incorporated with a capital stock of $5,000 by W. E. May, Herbert Crowley and M. E. Michaelson.

The Prairie Grove Electric Company, of Prairie Grove, Ark., has been incorporated with a capital stock of $6,000 by J. T. Carl, S. R. Wilson, W. R. Dodson and J. H. Zellner.

The Hemmingford Light, Heat & Power Company, of Hemmingford, Que., Can., has been incorporated by G. W. Keddy, O. Hebert and J. Faunier. The company is capitalized at $5,000.

The Electric Utilities Corporation, of Detroit, Mich., has filed articles of incorporation with a capital stock of $50,000. The incorporators are Bethune Duffield, Muir Duffield and John F. Baker.

The Otsego Power & Manufacturing Company, of Otsego, Mich., has been incorporated with a capital stock of $10,000 for the purpose of building a hydroelectric power plant and distributing electricity.

The Vinal Haven Electric Company, of Vinal Haven, Maine, has been incorporated with a capital stock of $100,000. The directors are Thomas E. Libby, Frederick S. Walls, of Vinal Haven, and John E. Liggett, of Augusta, Maine.

The Electric Service Company, of Milltown, Ind., has been incorporated by David S. Cook, Harry Lemmon, Henry S. Gray, and others. The company is capitalized at $5,000 and is organized in order to generate and distribute electrical energy.

The Economy Electric Light & Power Company, of Blandinsville, Ill., has been incorporated by G. L. Mallery, P. L. Barrett and C. A. Stevens. The company is capitalized at $20,000 and proposes to supply electricity for lamps, heaters and motors.

The Babylon Power Corporation, of New York, N. Y., has been incorporated by John V. Flood, Edgar Hirschberg and Daniel E. Hanlon, 2646 Morris Avenue, New York, N. Y. The company is capitalized at $10,000 and proposes to supply electricity for lamps, heaters and motors.

New Industrial Companies

The Baker-Joslyn Company, of San Francisco, Cal., has been incorporated with a capital stock of $10,000 to manufacture general electrical supplies. The incorporators are A. P. Baker, C. G. A. Baker, H. F. Hartzell and M. L. Joslyn.

The People's Service Electric Company, of Trenton, N. J., has been chartered with a capital stock of $125,000 by C. B. Lasell, Elmer W. Bogart and Orris M. Driscoll. The company proposes to manufacture and deal in electrical machinery.

The Colonial Electric & Manufacturing Company, of Oneonta, N. Y., has been chartered with a capital stock of $35,000 by A. E. Ceperly, J. S. Lunn and W. F. Eggleston, of Oneonta. The company proposes to deal in merchandise, realty patents, inventions, etc.

The Carbomobile Corporation, of Brooklyn, N. Y., has been incorporated by T. T. Wells, R. Gerbracht, Jr., and G. H. Fitzgerald, 13 Cedar Street, New York, N. Y. The company is capitalized at $150,000 and proposes to manufacture machines, motors, engines, etc.

Ryan & Dippel, of New York, N. Y., have been incorporated with a capital stock of $5,000 to do a general electrical and mechanical engineering business. The inporators are William T. Dippel, 1742 Second Avenue, New York; James A. Ryan and George F. Orr.

The Avery & Loeb Electric Company, Columbus, Ohio, has been incorporated with a capital stock of $100,000 for the purpose of conducting a general electrical, gas and steam construction supply business. The incorporators are Oscar Avery, A. E. and A. W. Loeb, C. W. Hammond and A. L. Frey.

Trade Publications

Trolley Wire.—"Phono-Electric" trolley wire is the subject of a folder issued by the Bridgeport Brass Company, Bridgeport, Conn.

Electric Washer.—The Meadows Manufacturing Company, Pontiac, Ill., has prepared an illustrated booklet entitled "Family Power Washer."

Inclosed Fuses.—The Chelton Electric Company, Philadelphia, Pa., has recently issued a bulletin which lists its fuses of the inclosed type.

Ball Bearings.—The Bantam Anti-Friction Company, Bantam, Conn., contains information on a number of different types of ball and roller bearings.

Glass Insulators.—Bulletin No. 55 published by the Brookfield Glass Company, 2 Rector Street, New York, lists a number of different types of glass insulators.

Fire-Alarm Devices.—W. R. Ostrander & Company, 22 Dey Street, New York, have issued a booklet which describes and illustrates various types of fire-alarm devices.

Electric Fans.—The Eck Dynamo & Motor Company, Belleville, N. J., has prepared a booklet which describes and illustrates several of its electrically operated fans.

Portable Air Compressor.—The Brunner Manufacturing Company, Utica, N. Y., has issued several leaflets which describe its No. 66 portable motor-driven tire inflator.

Automobile Tungsten Lamps.—The Vosburgh Miniature Lamp Company, West Orange, N. J., is sending out a leaflet which describes its nitrogen-filled automobile lamps.

Metal Box.—The Sterling Foundry & Machine Company, Newark, N. J., is sending out Bulletin No. 11, which describes a box for wire, covered by flexible tubing.

Electric Fans.—The Fidelity Electric Company, Lancaster, Pa., has published Catalog No. 27, which lists and illustrates a number of types of electrically operated fans.

Reasons for Trade-Mark.—The National Carbon Company, Cleveland, Ohio, is sending out a leaflet which outlines its reasons for choosing three pyramids as its trade mark.

Combination Switch.—The Trumbull Electric Manufacturing Company, Plainville, Conn., is sending out a leaflet which describes and illustrates its No. 701 combination switch.

Fire-Alarm Apparatus.—The Autocall Company, Shelby, Ohio, has issued a booklet which describes its interior fire-alarm system for operating on central-station direct-current circuits.

Electrically Operated Air Compressors.—The Utility Compressor Company, Detroit, Mich., has prepared a folder which describes two types of its rotary-driven air compressors.

Electric Fans.—The Allied Electric Company, 105 North Clark Street, Chicago, Ill., has issued a booklet which illustrates and lists a number of different types of electrically operated fans.

Bi-polar Motors and Generators.—Bi-polar direct-current motors and generators are listed in a leaflet designated as Series H, published by the Peerless Electric Company, Warren, Ohio.

Direct-Current Motors.—The type C direct-current motors, with ratings of 1 hp to 3 hp, manufactured by the Robbins & Myers Company, Springfield, Ohio, are described in Bulletin No. 125.

Electric Fans.—Various types of electrically operated fans are described and illustrated in a booklet entitled "Diehl Fans," just issued by the Diehl Manufacturing Company, Elizabeth, N. J.

Automobile Battery-Charging Outfit.—The Hertner Electric & Manufacturing Company, Cleveland, Ohio, has prepared a folder which describes its vertical battery-charging unit for automobiles.

Outlet-Box Attachment.—A folder describing several types of outlet-box attachments has been prepared by James G. Phelps, Springfield, Mass., for whom L. E. Frorup & Company, 232 Greenwich Street, New York, are sole distributers.

Tubular Ammeter.—A small tubular ammeter for use on battery circuits and other circuits up to 30 amp is described in a leaflet being sent out by the Benford Manufacturing Company, Mount Vernon, N. Y.

Fans and Small Motors.—The Knapp Electric & Novelty Company, 511 West Fifty-first street, New York, is sending out a supplement to its Catalog No. 23 which describes and illustrates small motors and fans.

Fire Extinguisher.—The Justrite Manufacturing Company, Van Buren Street and Clinton Street, Chicago, Ill., is sending out a booklet which describes and illustrates its fire extinguisher and fire-prevention devices.

Motor-Generator Outfit for Motion-Picture Service.—J. H. Halberg, 36 East Twenty-third Street, New York, has issued a catalog which describes and illustrates several machines designed for motion-picture service.

Electric Lantern.—The Illuminating Electric Manufacturing Company, Philadelphia, Pa., has prepared a booklet entitled "The Daylight Lantern," which describes a battery-operated lantern inclosed in a wooden case.

Hickeys and Insulating Joints.—The Trumbull Electric Manufacturing Company, Plainville, Conn., is sending out a folder which illustrates and lists several types of malleable-iron insulating joints and hickeys.

Electrically Operated Pumps.—The Fort Wayne Engineering & Manufacturing Company, Fort Wayne, Ind., has recently prepared Bulletin No. 4073, which describes several types of small electrically operated pumps.

Electrically Operated Fans.—"Gyrofans and Their Applications" is the title of Catalog No. 139 just issued by the Adams-Bagnall Electric Company, Cleveland, Ohio, which shows a number of applications of its "gyrofans."

Ophthalmometer.—"The One Position C-I Ophthalmometer" is the subject of a catalog which describes an electrically illuminated eye-testing device. The catalog has been issued by F. A. Hardy & Company, Chicago, Ill.

Electric Lamps for Photographic Purposes.—Bulletin No. 58 issued by the Cooper Hewitt Electric Company, 87 Grant Street, Hoboken, N. J., describes and illustrates its direct-current and alternating-current outfit for photographic work.

Linemen's Protectors.—The Linemen Protector Company, 172 Griswold Street, Detroit, Mich., has issued a twenty-page booklet illustrating and describing its linemen's shields and cross-arm protectors and reproducing testimonial letters from companies using these devices.

Charging Plugs and Receptacles.—Bulletins No. 31 and No. 32 issued by the Albert & J. M. Anderson Manufacturing Company, Boston, Mass., contain information on various types of charging plugs and receptacles for electric vehicles and batteries on railway cars.

Turbo-Generator Sets.—The Ridgway Dynamo & Engine Company, Ridgway, Pa., has recently published Bulletin No. 27, which describes several types of turbo-generator sets, the turbine of which is an impulse-type machine based on the patents of Prof. A. Rateau, of Paris, France, and Mr. C. H. Smoot, of New York.

Switching Apparatus.—The Albert & J. M. Anderson Manufacturing Company, 289 A Street, Boston, Mass., has issued a supplement to Bulletin No. 30 on automatic time switches, Bulletin No. 26 on induction-motor starting switches, and Bulletin No. 23 on various types of switches and switchboard appliances.

Electrical Apparatus.—Bulletin No. 48,100 issued by the Fort Wayne Electric Works of the General Electric Company, Fort Wayne, Ind., contains information on a commutating-pole direct-current crane and hoist motor, Bulletin No. 45,201 on transformers with high ratings, and Bulletins No. 46,100 and No. 46,101 on its type M and type P demand indicators.

Lighting Fixtures.—The National X-Ray Reflector Company, Chicago, Ill., is sending out several attractive plates which contain illustrations and diagrams of various types of lighting units. Plate No. 27 is devoted to portable lamps and brackets, plate No. 28 to the lighting of billiard and bowling rooms, plate No. 39 to fittings for direct-lighting reflectors, and plate No. 40 to the lighting of machine shops. The above company is also sending out a leaflet entitled "Sample Lighting Report for the Sanger (Cal.) High School."

Construction News

New England

WINTHROP, MAINE.—Within the next three months the Winthrop & Wayne Lt. & Pwr. Co., of Winthrop, expects to purchase 100 electric flatirons.

BOSTON, MASS.—Bids will be received by the Boston Infirmary Trustees, Room 51, City Hall, Boston, until April 13 for furnishing and installing automatic telephone equipment at the Long Island Hospital. Forms of proposal and other information may be obtained at the above office.

BOSTON, MASS.—Bids will be received by the Schoolhouse Commissioners of the city of Boston, Room 1009, City Hall Annex, Boston, until April 13 for furnishing and installing a vacuum cleaning system in the High School of Commerce. Proposal forms and further information may be obtained at the above office.

LYNN, MASS.—Bids will be received at the office of George A. Cornet, commissioner of public property, City Hall, Lynn, until April 13 for installation of electrical wiring and lighting system in the new addition of the English High School in the city of Lynn. Specifications and form of contract may be obtained at the above office.

SPENCER, MASS.—The Spencer Gas Co. will extend its primary lines about 5 miles, for which material has already been purchased.

NEWPORT, R. I.—The Newport & Fall River St. Ry. Co., of Newport, expects to purchase within the next six months a small quantity of transformers, meters, wire and incandescent lamps; also electrical appliances, including heating and cooking apparatus, vacuum cleaners, washing machines, etc. E. P. Gosling is superintendent of the illuminating department.

Middle Atlantic

BALDWINSVILLE, N. Y.—The Village Board has entered into a contract with the Seneca River Pwr. Co. for a new street-lighting system, which provides for the installation of 150 250-watt tungsten lamps, to replace the arc lamps now in use.

HOLLY, N. Y.—Bonds to the amount of $5,000 have been voted for improvements to the municipal electric-light plant. It is proposed to change the system from 133 cycles to 60 cycles.

MORRISTOWN, N. Y.—The Gregory El. Co., of Morristown, expects to make extensive changes in its plant, but as yet nothing definite has been decided upon. J. M. Gregory is manager.

NEW YORK, N. Y.—Bids will be received by C. B. J. Snyder, superintendent of school buildings, Department of Education, Park Avenue and Fifty-ninth Street, New York, until April 19 for installing electric ash hoists in Public Schools 45, 50, 52 and 53, borough of the Bronx. A separate proposal must be submitted for each school. Blank forms, plans and specifications may be obtained or seen at the above office.

NEW YORK, N. Y.—Bids will be received by Patrick Jones, superintendent of school supplies, Department of Education, Park Avenue and Fifty-ninth Street, New York, until April 15 for furnishing supplies for sign painting, machine shop, drawing, sheet metal, electric wiring, plumbing, etc., for the pre-vocational schools, Department of Education. Blank forms and further information may be obtained at the above office.

NEW YORK, N. Y.—Bids will be received by the board of trustees of Bellevue and Allied Hospitals, Bellevue Hospital, 415 East Twenty-sixth Street, New York, until April 19 for furnishing and installing all gas and electric fixtures for the various locations in the main building and the new ward extension to the Harlem Hospital, 136th and 137th Streets and Lenox Avenue, borough of Manhattan. Blank forms and further information may be obtained at the office of the contract clerk and auditor, 400 East Twenty-ninth Street, New York. John W. Bannan, M.D., is president.

NEW YORK, N. Y.—The Public Service Commission has adopted a resolution proposed by Commissioner Milo R. Maltbie directing the counsel to prepare an order to the Interborough Rapid Transit Co. which shall provide for certain improvements to be made to the subway as follows: (1) The installation of a separate telephone system with telephone stations at frequent intervals along the roadway between stations; (2) an improved lighting system throughout the subway; (3) an additional independent source of power for operating the ventilating fans; (4) rearrangement of power, signal and light cables in manholes; (5) installation of ventilating outlets for existing manholes required; (6) additional ladders and stairways from the subway to the street through existing ventilating chambers. The cost of the proposed changes is estimated at about $1,000,000.

BEAVERTOWN, PA.—A special election will be held April 17 to vote on the proposal to purchase the plant of the Beaver El. Co., to be taken over and operated by the municipality.

BOYERTOWN, PA.—The Boyerton El. Co. is contemplating extending its transmission lines to Gabelsville to supply electrical service there.

HOLTWOOD, PA.—The Pennsylvania Wtr. & Pwr. Co., of Holtville, it is reported, has contracted to supply energy to operate the Maryland and Pennsylvania electric railway, between Baltimore and York, and for the Ephrata & Lebanon Traction Co.'s system.

JERSEY SHORE, PA.—Within the next three months the Jersey Shore El. Co. expects to purchase material for new street-lighting system, including brackets and center suspension fixtures for about 126 Mazda lamps. The company has entered into a ten-year contract with the borough of Jersey Shore for street-lighting, which has been submitted to the Public Service Commission of Pennsylvania for approval. If approved, the above system will be installed. H. C. Westphal is superintendent.

JOHNSTOWN, PA.—Preparations are being made by the Dale Lt., Ht. & Pwr. Co., of Johnstown, for extending its system to cover the entire municipality, under a franchise granted two years ago. The company, it is understood, contemplates the construction of a new power plant.

NEW CASTLE, PA.—The contract for equipping the plant of the New Castle Rubber Co. for electrical operation has been awarded to the New Castle El. Co.

PHILADELPHIA, PA.—A permit has been granted for the construction of a power house at Thirty-fifth Street and Gray's Ferry Avenue, Philadelphia, for Harrison Brothers & Co. Wadleigh & Osbourne, Real Estate Trust Building, Philadelphia, are engineers.

READING, PA.—The Metropolitan El. Co. has begun work on the erection of a high-tension transmission line from its power plant at West Reading to Birdsboro, a distance of about 10 miles.

WILKES-BARRE, PA.—The entire mining operations at the Keystone Colliery, near Wilkes-Barre, will, it is reported, be equipped with electrically operated machinery. Locomotives will take the place of mules and electrical machinery will replace steam-driven machines in the breakers.

WILLIAMSPORT, PA.—The City Council has granted the Merchants' Association permission to install an ornamental lighting system on West Third Street between Pine and West Streets. The merchants, it is understood, will install the lamps and the city will maintain the same.

BAYONNE, N. J.—In connection with improvements and extensions at its Constable Hook plant the Standard Oil Co. is contemplating the installation of an electric power plant. The company proposes to replace steam power with electricity wherever possible.

HAMPTON, N. J.—The Standard Water Systems Co., of New York, N. Y., has awarded the contract for the construction of its new plant in Hampton (to cost $25,000), to W. A. Stein & Co., of Allentown, Pa. Plans for the electrical work will be completed in the near future.

NEWARK, N. J.—The Board of Works is considering a proposition for the installation of a destructor plant on the Newark Meadows, to provide electrical energy for local lighting and storage-battery service for jigger cars.

ROOSEVELT, N. J.—The Pub. Ser. Co. is contemplating building an addition to its substation in Roosevelt and increasing the present output of the plant.

UNIONTOWN, N. J.—The contract for the construction of the new school building in Uniontown has been awarded to the Phillipsburg Supply & Construction Co., of Phillipsburg, by the Hopatcong Township Board of Education. Special attention will be given to the lighting and ventilating systems.

UNION, W. VA.—The Town Council has granted E. H. Butts, of White Sulphur Springs, a franchise to construct and operate an electric-light plant for a period of 50 years. Electricity for operating the system, it is reported, will be supplied by the Virginia-Western Pwr. Co., of Clifton Forge.

WESTON, W. VA.—The City Council has granted Richard V. Malloy and James M. Malloy a franchise to construct and operate an electric-light plant.

EASTVILLE, VA.—The installation of an electric-lighting plant in Eastville is reported to be under consideration. Mr. Justice, owner of the Onacock plant, it is understood, is interested in the project.

ST. CHARLES, VA.—Transmission lines are being erected by Samuel Insull, of Chicago, Ill., and associates, who own the plant at St. Charles, Lee County, over the mountains into eastern Kentucky, where, it is said, local municipalities will be supplied.

STUART, VA.—Bids will be received by the city of Stuart until April 16 for the sale of a franchise to construct and operate an electric-light plant. M. D. Bailey, Jr., is Mayor.

WASHINGTON, D. C.—Bids will be received at the office of the supervising architect, Treasury Department, Washington, D. C., until April 24, for furnishing lamp standards, etc. For further information address O. Wenderoth, supervising architect.

WASHINGTON, D. C.—Plans are being prepared by Milburn, Heister & Co., 603 Union Savings Bank Building, Washington, D. C., architects, for the Potomac El. Pwr. Co., Fourteenth and C Streets, for construction of a building (92 ft. by 96 ft., five stories high) to cost about $70,000.

WASHINGTON, D. C.—Bids will be received by the Secretary of the Interior, Department of the Interior, Washington, D. C., until April 17 for the purchase and removal of old electrical material and 100,000 lb., more or less, of old copper wire and cables (with insulation burned off) now stored at the government hospital for the insane, Anacostia, D. C.

WASHINGTON, D. C.—Foreign trade opportunities are announced by the Bureau of Foreign and Domestic Commerce in the Commerce Reports as follows: No. 16,130—An American consular officer in Brazil reports that a firm of merchants and exporters of Brazilian woods is prepared to undertake an agency for the sale of electric lamps and fixtures, agricultural implements, etc. No. 16,132—An American consular officer in Brazil reports that a business man in his district wishes to represent American manufacturers and exporters of electrical supplies, porcelain, glass and earthenware. Catalogs and discount sheets should be sent at once. No. 16,150—A business man in Mexico has informed an American consul that he is preparing to open a store for the sale of American electrical supplies and machinery. No. 16,173—An American consul in Spain reports that a business man in his district desires to secure information relative to electrical goods, such as bulbs, heaters, irons, etc. Catalogs and correspondence should be in Spanish. No. 16,175—An American consular officer in France reports that a business man in his district wishes to represent American exporters and manufacturers of electrical bells, etc. No. 16,233—An American consular officer in Spain reports that a business man in his district has requested that he be supplied with samples, prices, etc., on electrical supplies for continuous current, voltage, 110 to 130. He is especially interested in enameled attachment plugs, etc., contacts, switches, sockets of all kinds, insulated wires, flatirons, warming pads and heaters. Correspondence must be in Spanish. No. 16,259—An American consular officer in England reports that a firm in his district desires to be placed in communication with American manufacturers in inner globes, heat-resisting glass, for arc lamps. No. 16,287—A business men in Italy informs an American consular officer that he wishes to receive quotations, samples, etc., relative to kerosene lamps, gas mantles and dry batteries for electric pocket lamps. No. 16,290—A business man in France informs an American consular officer that he desires to be placed in communication with American manufacturers of incandescent lamps. Further information may be obtained upon application to the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C., or its branches.

WASHINGTON, D. C.—Bids will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until April 13, for furnishing at the various navy yards and naval stations the following supplies: Newport, R. I., Schedule 8101—20,000 ft. iridium platinum wire. Brooklyn, N. Y., Schedule 8102—12,000 ft. 5/8-in. hoisting wire. Schedule 8092—2500. lb. soft sheet copper. Bids also will be received at the same place until April 20, as follows: Mare Island, Cal., Schedule

8097—3000 lb. sheet copper. Portsmouth, N. H., Schedule 8107—5400 lb. condenser-tube sheets. Hospital, Norfolk, Va., Schedule 8109—one X-ray apparatus. Bids will also be received until April 27 as follows: Mare Island, Cal., Schedule 8112—one water-tube boiler. Washington, D. C., Schedule 8117—five split switches, 28 dozen glass tubes for condenser. Brooklyn, N. Y., Schedule 8135—miscellaneous open-type blowers; Schedule 8150—400 ft. phosphor bronze chain, 12,000 lb. amorphous lubricating graphite; Schedule 8148—4500 ft. interior communication cable, 400 receiver cords for radio headgears, miscellaneous stuffing tubes, type A, 5000 ft. plain single-conductor wire, 150,000 ft. plain twin-conductor wire, miscellaneous magnet wire, 2300 ft. rat-tail wire; Schedule 8147—75,000 ft. of incandescent lamp cord. Schedule 8163—motor-generators, etc. Schedule 8147—4500 lb. weatherproof wire, miscellaneous lighting and power wire. Melville, R. I., Schedule 8128—miscellaneous plow-steel wire cable. Boston, Mass., Schedule 8156—2000 lb. brass voice tubing. Charleston, S. C., Schedule 8150—miscellaneous copper tubing. Newport, R. I., Schedule 8131—50 ft. platinum wire. Philadelphia, Pa., Schedule 8131—5000 ft. insulated flexible wire; Schedule 8130—four generator sets. Washington, D. C., Schedule 8131—300 steel tubes; Schedule 8143—3000 ft. weatherproof cable. Works of manufacturer, Schedule 8146—540 porcelain insulators. Bids will also be received until May 4 as follows: Mare Island, Cal., Schedule 8113—miscellaneous condenser-tube sheets, sheet copper, and condenser tubes; Schedule 8114—miscellaneous safety valves; Schedule 8157—miscellaneous arc-lamp carbons. Washington, D. C., Schedule 8169—two silent-chain drives, two induction motors, four pumping outfits. Norfolk, Va., and Charleston, S. C., Schedule 8170—two steering engines. Norfolk, Va., Schedule 8171—two meat and food electric grinders. Brooklyn, N. Y., Schedule 8172—furnishing and installing 23 oil indicators. Puget Sound, Wash., Schedule 8164—miscellaneous switchboards, etc., transformers. Bids will also be received until June 1 for furnishing one transmitting radio set at Brooklyn, N. Y., as per Schedule 8121. Applications for proposals should designate the schedule desired by number.

North Central

BLISSFIELD, MICH.—The Electric Light Commission expects to build an addition to the municipal electric-lighting plant and establish a 24-hour service within the next two months; also to purchase a new switchboard for a two-unit plant.

CAMDEN, MICH.—At a special election held recently the proposal to grant a franchise to Mr. Griggs to install an electric-light plant in Camden was carried. Arrangements have also been made for lighting the streets of the village

DETROIT, MICH.—The stockholders of the Detroit United Ry. Co. have authorized the directors of the company to accept the offer of the city of Detroit to purchase the city railway lines for $24,900,000. As soon as details are arranged a special election will be called to submit the proposition to the voters.

HOWELL, MICH.—The Spencer-Smith Machine Co. is arranging to double its electrical power service and install new motors.

OTTAWA BEACH, MICH.—Preparations are being made by the Grand Rapids-Muskegon Pwr. Co., of Grand Rapids, for furnishing a 24-hour lighting service in Ottawa Beach and in the Black Lake District. A new plant, it is understood, will be installed.

SAULT STE. MARIE, MICH.—The Northern Michigan Pwr. Co., it is reported, will begin work this month on the new compensating works above the Soo Rapids, which will involve an expenditure of about $250,000. The plant of the Northern Michigan Pwr. Co., it is reported, will close down soon for extensive repairs.

CLEVELAND, OHIO.—Bids will be received at the office of the commissioner of purchases and supplies, 511 City Hall, Cleveland, until April 15,, for water-tube boilers for the Department of Utilities, division of water. Specifications may be obtained from the commissioner of water, 413 Superior Avenue.

COLUMBUS, OHIO.—The Ohio State Tel. Co. has decided to erect 604 miles of long-distance lines between Findlay and Fostoria, Milan and Lorain, Milan and Cleveland, Lima and Celina, Springfield and Bellefontaine, Milan and Elyria, and Columbus and Vernon, at a cost of $34,000.

DAYTON, OHIO—Plans are being considered, it is reported, for the installation of an electric-lighting system on Cincinnati Pike, from Stroop Road to Dorothy Lane.

LOCKLAND, OHIO.—The Union Gas & El. Co. has submitted a proposal to the village of Lockland, under which the company offers to dispose of its local plant to the village and to furnish energy to operate the same.

MANCHESTER, OHIO.—Within the next six months the Board of Public Affairs expects to purchase six street series tungsten-lamp fixtures. B. P. Stone is superintendent.

MANSFIELD, OHIO.—Bids will be received by Orra Hursh, director of public service, Mansfield, until April 23 for lighting the streets of the city with electricity for a period of ten years. Specifications may be obtained at the office of the director of public service or at the office of H. Whitford Jones, 1303 Citizens' Building, Toledo, consulting engineer.

ST. CLAIRSVILLE, OHIO.—The Town Council has decided to abandon the municipal electric-generating plant and purchase energy from the Wheeling Trac. Co. or from the Wheeling El. Co., of Wheeling.

ST. MARYS, OHIO.—T. E. Hollingsworth, Jr., clerk of the Service Department, writes that the Council has not taken any action nor has there been any agitation in reference to selling the municipal electric-light plant. In the issue of April 3 an item was published stating that it was reported that the Village Council had voted to sell the municipal electric-light plant.

CADIZ, KY.—The City Council is considering the question of lighting the streets of the town with electricity. The contract will probably be awarded to Mr. White, owner of the local plant.

LOUISVILLE, KY.—Bids will be received at the office of the supervising architect, Treasury Department, Washington, D. C., until April 30 for new plumbing fixtures, etc., in the United States post office, court house, etc., at Louisville, Ky. For details see proposal columns.

WHITESBURG, KY.—Arrangements, it is reported, are being made by Fred Starkey, of Somerset, and N. Starkey, of Pikesville, for the installation of an electric-light and power plant in Whitesburg.

BLOOMINGTON, ILL.—The commissioners of the Spring Lake Drainage District have petitioned the court for an additional assessment of $18,000, for the purpose of installing an electric generating plant at the pumping station in the district and to make other improvements. H. A. Bell is county surveyor.

CHICAGO, ILL.—Bids will be received by L. E. McGann, commissioner of public works, 406 City Hall, Chicago, until April 13, for furnishing and erecting one four-panel switchboard at the Marshall Boulevard municipal electric-light plant.

CHICAGO, ILL.—The Public Service Co. of Northern Illinois, 137 South La Salle Street, Chicago, is contemplating making large central-station investments and the usual increase in substation investment. As yet nothing definite has been decided upon.

CHICAGO, ILL.—Bids will be received by L. E. McGann, commissioner of public works, 406 City Hall, Chicago, Ill., until April 16, for furnishing at the Madison Street shops channel lamps of various types. Specifications may be obtained at the office of the Department of Public Works.

CHICAGO, ILL.—Bids will be received by L. E. C. Shankland, chairman of the Harbor and Subway Commission of the city of Chicago, Room 2001, City Hall Square Building, 139 North Clark Street, Chicago, until April 12, for furnishing and installing electrical equipment on Pier No. 2, Harbor District No. 1, according to plans and specifications on file in the above office.

PEORIA HEIGHTS, ILL.—Bids will be received by the Board of Local Improvements, Peoria Heights, until April 19 for construction of water-works system as follows: (a) 85,085 linear ft. cast-iron pipe with specials; (b) 98 hydrants, 69 valves and 69 valve boxes; (c) two centrifugal pumps directly connected to motors and electric control for same; (d) construction of pumping station; (e) construction of steel tower and 50,000-gal. tank. Plans and specifications may be seen at the office of E. J. Brayton, village clerk, Peoria Heights, or Charles H. Dunn, civil engineer, Arcade Building, Peoria.

STRONGHURST, ILL.—Preparations are being made by M. F. T. Schierbaum, owner of the local electric-light plant, for installing new equipment, consisting of one 65-hp Muenzel gas engine and one 75-hp Muenzel suction gas producer; also one 45-kw, 60-cycle, three-phase, 2300-volt generator (make not yet decided upon). The city contract for street-lighting calls for 40 parallel 60-watt tungsten lamps.

WATSEKA, ILL.—The proposal to establish a municipal electric-light plant in Watseka will be submitted to the voters at an election to be held some time this month.

GREENWOOD, WIS.—Within the next six months the town of Greenwood expects to make improvements to the municipal power station and repair waterwheel; also to purchase electrical supplies for new houses and church to be built in Greenwood this summer. G. V. Rork is superintendent and contractor.

SPOONER, WIS.—The City Council has applied to the Railroad Commission for permission to construct a dam on the Nemekagon River, near Trego, for the development of additional power for the municipal electric-lighting system.

CLARKFIELD, MINN.—The Clarkfield Roller Mills & El. Lt. Co. expects to purchase within the next 12 months wire and other material and poles to overhaul its lines; also meters, etc., and some electrical heating and cooking apparatus, etc.

JORDAN, MINN.—The Jordan El. Lt. & Htg. Co. expects to purchase within the next two or three months one boiler (about 150 hp), one 30-hp to 50-hp engine and three-wire, direct-current generator, directly connected; also within the next three or four months 2½ miles of wire for distributing lines. S. L. Sly is manager.

MINNEAPOLIS, MINN.—Bids will be received at the office of the supervising architect, Treasury Department, Washington, D. C., until May 4 for the installation of an electric push-button dumb-waiter in the United States post office in Minneapolis, Minn. For details see proposal columns.

MINNEAPOLIS, MINN.—Preparations are being made for the installation of a new 15,000-kw steam turbine unit in the Riverside steam station of the Minneapolis General Electric Company. The improvement will include the installation of condensing apparatus, boilers, building extension and necessary extension to coal-handling apparatus.

FAIRFIELD, IA.—Within the next two months the Fairfield Pub. Ser. Co. expects to purchase material for a 2-mile line extension; also material for wiring the Jefferson County court house. H. C. Stevenson is manager.

IRWIN, IA.—Plans, it is reported, are being prepared for the installation of an electric distributing system in Irwin, to cost about $6,000. Bruce, Standevin & Boynton, 430 Bee Building, Omaha, Neb., are engineers.

JEFFERSON, IA.—Within the next six months the Jefferson El. Co. expects to purchase one 150-kw, three-phase, 2200-volt generator, one 50-kw, three-phase, 2200-volt generator, new switchboard, including generator panels for above generators and for feeders. Percy Gray is manager.

MONTEZUMA, IA.—Within the next six months the Montezuma El. Lt., Htg. & Pwr. Co. expects to purchase a few electrical cooking utensils. George H. Huseman is superintendent.

SHELDON, IA.—Within the next three months the Sheldon Lt. & Pwr. Co. expects to erect about ½ mile of 2200-volt transmission line to connect with a 7-mile line being built by 14 farmers.

SPILLVILLE, IA.—The city of Spillville is reported to have granted a franchise to Robert Klimesh to install an electric-lighting plant.

CHILLICOTHE, MO.—Bids will be received by P. J. Dixon, secretary of the Board of Public Works, Chillicothe, until April 16 for construction of a filter and furnishing pumps, motors, etc., and other work in connection with improvements to water-works system. Plans and specifications are on file at the office of the Board of Public Works and at the office of Harper & Stiles, consulting engineers, 914 Grand Avenue, Temple, Kansas City, Mo.

CLARKSBURG, MO.—The Clarksburg Lt. & Pwr. Co. is contemplating the installation of an electric-lighting system, to cost about $4,000. The plans provide for the erection of about 7 miles of transmission line. Energy will probably be obtained from Tipton, Mo. For further information address G. P. Wilson, 324 Mifflin Avenue, Wilkinsburg, Pa., until May 1.

HUME, MO.—Within the next four months the Hume El. Co. expects to erect 17 miles of transmission lines to supply a farming community with electricity for lamps and motors.

KEARNEY, MO.—The Kearney El. Co. is contemplating extending its transmission line to a small town, about 6 miles distant, to supply electrical service there. As yet nothing definite has been decided upon. John A. Eby is manager.

ST. LOUIS, MO.—A plan to construct a 9-mile canal connecting the Missouri and Meramec Rivers near St. Louis, making available, it is declared, more than 100,000 hp of water-power, is being promoted by a commission headed by former State Senator Kirk Hawkins, of Springfield, Mo., and Senator S. E. Bronson, of Ozark. The canal would be cut between the towns of Mikkelson and Labadie in Franklin County, and with the plant and transmission line to St. Louis would cost, it is estimated, about $10,000,000. The State Senate commission recently appointed to recommend means of reforestation at the headwaters of state streams has recommended that a site and permit to erect a dam be secured by the State from the federal government.

SPRINGFIELD, MO.—Preparations are being made, it is reported, by the Heer-Andres Investment Co., proprietor of the new Heer Dry Goods Co., for the construction of a power plant to supply electricity to the store, to cost from $25,000 to $30,000, of which $18,000 will be expended for electrical equipment. Plans are being prepared by A. N. Torbitt, architect.

URICH, MO.—Plans are being prepared, it is reported, for the installation of a municipal electric-lighting plant in Urich, to cost about $5,000. For further information address H. Busse, of Urich.

DONNYBROOK, N. D.—W. S. McIntire, it is reported, is contemplating the installation of an electric-lighting plant in Donnybrook.

MINOT, N. D.—Improvements are contemplated to the power station of the Consumers' Pwr. Co., of Minot, which will include the installation of a 250-kw steam turbine and a 500-hp boiler.

BROOKINGS, S. D.—The town of Brookings expects to erect an addition to the municipal power station and to build a smokestack for 600-hp boilers within the next four months, also to purchase two 66-in. by 16-ft. horizontal boilers and water heaters, one 200-kw generating unit, one 120-kw generating unit, 2200 volts, two-phase, 60-cycle (both units directly connected), complete with switchboard. A. W. Morton is superintendent.

GOODWIN, S. D.—The installation of an electric-lighting system in Goodwin is under consideration by local capitalists.

DUNDEE, NEB. (not a post office).—At a special election to be held April 17 the proposal to issue $35,000 for the installation of an ornamental street-lighting system throughout the village will be submitted to the voters. Dundee is a suburb of Omaha.

GRAND ISLAND, NEB.—Plans, it is reported, are being considered for extensions to the distributing system of the municipal electric-light plant.

LOOMIS, NEB.—Plans are being considered, it is reported, by Abrahamson & Johnson for the installation of an electric-lighting plant and ice factory in Loomis.

NELSON, NEB.—Bids will be received by W. A. McHenry, city clerk, Nelson, until April 13 for furnishing (f.o.b.) and installing material, including poles, cross-arms, insulators, transformers, ornamental standards, conduit, wire, etc., for complete street-lighting, residential and commercial distributing system.

OMAHA, NEB.—The Omaha & Lincoln Ry. & Lt. Co. has been granted permission by the State Railway Commission to issue $130,000 in bonds and stocks, the proceeds to be used for the erection of electric transmission lines and other improvements.

TECUMSEH, NEB.—The city of Tecumseh is contemplating the installation of a 100-kw generator and engine (directly connected) in the municipal electric-light and water-works plant, but as yet nothing definite has been decided upon. W. R. Tasker is superintendent.

VALENTINE, NEB.—At an election held recently the proposal to grant Charles H. Cornell a franchise and an agreement to purchase energy from him to be distributed by the city was carried. Mr. Cornell proposes to build a plant on the Niobrara River, about 4 miles east of Valentine, and to supply the city with a 24-hour electric service.

McCRACKEN, KAN.—Preparations, it is reported, are being made for the installation of an electric-lighting plant in McCracken. Electricity for operating the system will be obtained from the La Crosse plant.

MOUND CITY, KAN.—The City Council is considering granting a franchise to a company for the installation of an electric-lighting plant in Mound City. The contract has not yet been closed, and the proposition remains open to any other party or company that cares to consider the same. John I. Sheets is city clerk.

Southern States

WAYNESVILLE, N. C.—At an election to be held May 4 the proposal to issue $25,000 in bonds to construct an electric light and power plant will be submitted to the voters.

DILLON, S. C.—Within the next three months the Electric Light and Water Commissioners expect to purchase one 30-kw three-phase, 60-cycle, 2200-volt generating unit (directly connected). W. H. Crow is superintendent.

HOGANSVILLE, GA.—The proposal to issue $5,000 in bonds for the construction of an electric-lighting plant will be submitted to the voters on April 21.

JONESBORO, GA.—Plans are being considered by W. R. Jeste, proprietor of the Old Mill Amusement Park, for improvements to resort, including the installation of a new lighting system, café buildings and electric generators, to cost about $2,000. Machinery, it is understood, has not been purchased.

LEXINGTON, GA.—A company is being organized under the name of the Oglethorpe Ltg. & Pwr. Co. for the purpose of installing an electric-lighting system in Lexington and Crawford. The capital stock is placed at $3,000.

RICHLAND, GA.—Bonds to the amount of $15,000 have been voted, of which the proceeds of $5,000 will be used for improvements to the municipal electric-light and water plant.

PABLO BEACH, FLA.—The city of Pablo Beach, it is reported, will construct an electric-lighting plant by day labor. The J. B. McCreary Co., of Atlanta, Ga., consulting engineer, has charge of the engineering work.

HOT SPRINGS, ARK.—Capitalists, it is reported, are contemplating establishing an amusement resort, including the erection of hotel and street-lighting system, etc., involving an expenditure of about $10,000,000. Henry Ives Cobb, 901 Lexington Avenue, New York, N. Y., is architect.

JONESBORO, ARK.—It is reported that equipment will be purchased for the State Agricultural School at Jonesboro as follows: One 50-kva alternating-current generator and engine (directly connected), two 150-hp marine-type boilers, reinforced-concrete smokestack (130 ft. by 5 ft.), 50,000-gal. steel tank, 125-ft. water tower, 10-in. well, duplex or triplex pump, etc. V. C. Kays, of Jonesboro, is principal.

GRETNA, LA.—The Gretna Lt. & Pwr. Co., recently incorporated with a capital stock of $50,000, is reported to have acquired the franchise and contract for the electric-lighting system in Gretna, now under construction. Dr. Charles F. Gelbke and others are interested in the company.

KENTWOOD, LA.—The contract for lighting the town with electricity, it is reported, has been awarded to the Brooks-Scanlon Co. Plans are being considered for the installation of a new plant.

EUFAULA, OKLA.—The Pioneer El. & Pwr. Co., of Eufaula, expects to purchase one 125-hp engine and one 100-kw generator. E. F. Sattsman is treasurer and manager.

BRYAN, TEX.—Bids will be received at the office of the supervising architect, Treasury Department, Washington, D. C., until May 15 for the construction, including the mechanical equipment, interior lighting fixtures and approaches, of the United States post office in Bryan. Drawings and specifications may be obtained from the above office or from the custodian of site at Bryan. O. Wenderoth is supervising architect.

DALLAS, TEX.—The contract for wiring the Dallas Union Terminal station has been awarded to the C. M. Cockrell Co., of Dallas.

HASKELL, TEX.—The Haskell Lt. & Ice Co., recently organized with a capital stock of $20,000, proposes to install an electric-light plant and ice factory in Haskell. Morgan Jones is interested in the project.

ORANGE, TEX.—The Orange Ice, Lt. & Wtr. Co. is changing its system from 133 cycles to 60 cycles. Contract for equipment has been awarded to the Westinghouse El. & Mfg. Co.

VICTORIA, TEX.—At an election to be held April 26 the proposal to issue $40,000 in bonds for the construction of a municipal electric-lighting plant will be submitted to the voters.

Pacific States

CATHLAMET, WASH.—C. H. Reeves, of Jefferson, Ore., has applied to the City Council for a 10-year franchise to construct and operate an electric-light plant in Cathlamet. Under the terms of the proposed franchise the city is given the privilege to purchase the system at the expiration of same.

PE ELL, WASH.—The Lewis County Lt. & Pwr. Co., represented by C. Oliver Smith, has applied to the City Council for a franchise to construct and operate an electric light and power system in Pe Ell for a period of 50 years. The company also asks for a 10-year contract for street-lighting.

SEATTLE, WASH.—Bids will be received by C. E. Remsberg, secretary of the Board of the Port of Seattle, Central Building, Seattle, until April 21 for the installation of a light and power plant in the fruit-storage building of the East Waterway Terminal improvement of the port of Seattle, in accordance with plans on file in the office of the secretary of the port board. Bidders may also submit alternative proposals upon designs of their own.

TACOMA, WASH.—The City Council has taken under consideration the proposition submitted by E. G. Griggs, of the St. Paul & Tacoma Lumber Co., of Tacoma, in which the company offers to enlarge a proposed power plant at its mill so that it could be used as an auxiliary to the municipal electric-light plant. If the city decides to accept the offer, the company will guarantee to furnish the city with 10,000 hp, which will be needed during the summer months especially. The City Council already has a tentative agreement with the Tacoma Central Htg. Co. to equip that company's proposed plant as an auxiliary.

PRAIRIE CITY, ORE.—The Prairie Pwr. Co., it is reported, is contemplating removing its power plant, which is situated 3 miles from this city, to its mill near the depot. It is understood that some improvements will be made to the plant and additional machinery installed.

SACRAMENTO, CAL.—A petition asking that a new lighting district be formed to include the blocks bounded by J and K and Fourth and Sixth Streets, for improving the lighting system, will be presented to the City Commissioners by the business men of that section.

STOCKTON, CAL.—A new turbine-driven generating unit (water) will be installed in the hydroelectric plant of the Western States Gas & El. Co., Stockton, California division, on the American River, and an additional boiler will be installed in steam station "B."

VISALIA, CAL.—The Mount Whitney Pwr. & El. Co., of Visalia, has been authorized by the State Railroad Commission to issue $238,000 in bonds, the proceeds to be used as follows: Completion of steam plant, $76,400; distribution lines and substations, $83,858; main-line extensions, $86,963; meters and small transformers, $8,310; miscellaneous additions, $15,686; Kaweah power plant No. 1, $313; Keweah power plant No. 3, $25,614; Tule River plant, $423.

SALT LAKE CITY, UTAH—Plans are being prepared, it is reported, by the Utah Ltg. & Trac. Co. for the installation of an ornamental lighting system in the business district.

PRESCOTT, ARIZ.—Application has been made to the Corporation Commission by the Arizona Pwr. Co., of Prescott, for permission to issue notes and bonds to secure funds for the construction of another power plant on Fossil Creek, in Yavapai County, the cost of which is estimated at $340,000.

CHOUTEAU, MONT.—The Montana Pwr. Co., of Great Falls, has taken over the local electric-light plant, owned by Homer McCullogh. The Montana company will erect a transmission line, 12 miles long, from the United States Reclamation Service headquarters at Sun River Canyon this spring.

LANDER, WYO.—The Lander El. Lt. & Pwr. Co., of Lander, is reported to be contemplating the installation of an electric generating station and distributing system in Dubois.

SHERIDAN, WYO.—The installation of an ornamental lighting system in the business section of the city is under consideration.

BATTLE MOUNTAIN, NEV.—The installation of an electric-light plant in Battle Mountain is under consideration. H. G. Christensen, St. Clair Moore and H. R. Lemaire are reported to be interested.

Canada

DUNCAN, B. C.—New equipment is being installed in the municipal electric-lighting plant, consisting of two slow-speed Diesel engines, two 60-kva Westinghouse alternators, directly connected to engines, and two 7-kw exciters. F. Cameron is city engineer.

Weekly Record of Electrical Patents

UNITED STATES PATENTS ISSUED MARCH 30, 1915.

[Prepared by Robert Starr Allyn, 16 Exchange Place, New York, N. Y.]

1,133,252. Car Truck; W. S. Adams, Philadelphia, Pa. App. filed June 5, 1913. For storage-battery cars.

1,133,259. Method of Quick Graphitization of Carbon Articles; J. W. Brown, Lakewood, Ohio. App. filed May 6, 1912. Uses current of high density.

1,133,263. Trolley Restorer; L. T. Chrisman, Buffalo, N. Y. App. filed Aug. 24, 1910. Operable from either end of car.

1,133,264. Telephony; H. P. Clausen, Rochester, N. Y. App. filed Jan. 12, 1912. Uniform distribution of calls.

1,133,268. Process of Uniting Metal Bodies; L. P. Crecelius, Cleveland, Ohio. App. filed June 18, 1913. Brazing copper bands to rails.

1,133,285. Snap Switch; C. Horn, Millbourne, Pa. App. filed Oct. 13, 1913. Flush-plate wall type, lever-operated.

1,133,291. Selective Signaling System; E. E. Kleinschmidt, New York, N. Y. App. filed Sept. 8, 1910. Has slow-acting magnet and other features.

1,133,296. Electric-Railway System; P. W. Leffler (deceased), Chicago, Ill. App. filed Aug. 13, 1908. Embodying electromagnets along roadbed.

1,133,307. Electrical Signal; G. C. Murphy, Louisville, Ky. App. filed Jan. 4, 1913. Apprises one alighting from car of approach of car on opposite track.

1,133,316. Transformer; A. H. Pikler, Montclair, N. J. App. filed March 17, 1910. Magnetic leakage and eddy currents minimized.

1,133,833—Head Support for Telephone Receivers

1,133,338. Protective Device for Busbar Circuits; P. Torchio and H. R. Woodrow, New York, N. Y. App. filed April 24, 1914. For limiting the total current set up in a circuit by reason of a short-circuit or other fault.

1,133,346. Electric-Heating Stopper for Liquid Containers; E. C. Webster and H. Gruenhagen, Oakland, Cal. App. filed April 30, 1914. Heating stopper for hot-water bags.

1,133,361. Signaling Device; J. R. Casper, Washington, D. C. App. filed May 6, 1914. For automobiles.

1,133,366. Warp-Stop Motion for Looms; S. B. Cutting, Bridgeport, Conn. App. filed Nov. 26, 1912. Circuit-controlling drop devices supported by unbroken pile warps.

1,133,370. Electric Piano Player; P. J. Dreher, Toledo, Ohio. App. filed May 11, 1911. Resistances automatically controlled to vary degree of loudness.

1,133,373. Subscriber-Controlled Switching Apparatus for Telephone Exchange Systems; J. Erickson, Chicago, Ill. App. filed Nov. 12, 1906. Improved arrangement and mode of operation.

1,133,403. Trolley-Line Hanger; C. H. Robertson, Peoria, Ill. App. filed Dec. 26, 1914. Catenary construction.

1,133,435. Method of and Apparatus for Reproducing Impulses; R. A. Fessenden, Brookline, Mass. App. filed Feb. 9, 1914. Reproducing and amplifying phonographically recorded sounds.

1,133,441. Inductance Device for Wireless Electrical Signaling; C. O. Lorenz, Port Arthur, Tex. App. filed Nov. 7, 1910. Improved tuning transformer.

1,133,447. Current-Rectifying System; C. W. Sirch, Los Angeles, Cal. App. filed Jan. 16, 1907. Electrolytic condensing interrupter.

1,133,448. Circuit-Closing Device; J. W. Smith, Youngstown, Ohio. App. filed Aug. 31, 1914. Push for concealment beneath carpets, etc., for buzzers.

1,133,449. Multicontact Relay; H. G. Webster, Chicago, Ill. App. filed April 11, 1912. Compact assembly; simple construction.

1,133,452. Carburetor; M. E. Babbitt, Brookfield, and J. F. Beaumont, Worcester, Mass. App. filed July 22, 1912. Heater warms fuel just prior to its mixing with air.

1,133,455. Interval Demand-Indicating Mechanism; J. W. Bard, Peoria, Ill. App. filed Dec. 18, 1911. Makes record on chart.

1,133,466. Measuring Transformer; M. Gewecke and C. Baeumler, Nuremberg, Germany. App. filed Nov. 3, 1914. Ratio of transformation adjustable during manufacture or during testing.

1,133,524. Electric Current Conducting and Distributing Means; F. A. Zika, Chicago, Ill. App. filed June 9, 1913. Distributer directly connected to spark plugs.

1,133,535. Outlet-Box Hanger; F. L. Cain and C. J. Borff, Chicago, Ill. App. filed Aug. 11, 1914. Laterally adjustable to suit the distance between joists.

1,133,549. Party-Line Cut-Out; W. B. Francis, Prague, Okla. App. filed June 14, 1913. Eavesdropping preventer operated by receiver hook.

1,133,569. Fuse Clip; H. N. Müller, Pittsburgh, Pa. App. filed July 15, 1914. For heavy-current knife-blade contact fuses.

1,133,578. Electrical Metal-Working Apparatus; A. F. Rietzel and G. E. Barstow, Charlestown, R. I. App. filed Nov. 20, 1908. Metal is electrically heated as it progresses through machine.

1,133,579. Electric Heating Element; E. J. Röhne, Minneapolis, Minn. App. filed Oct. 30, 1913. Flexible pad.

1,133,597. Recording Instrument; C. H. Wilson, Mount Vernon, N. Y. App. filed Jan. 7, 1914. Has a pointer and striker.

1,133,628. Galvanizing Wire, Hoops, Sheets and the Like; H. H. Field, Grappenhall; M. Howarth, Latchford, and E. A. Atkins, Liverpool, Eng. App. filed Feb. 11, 1913. Hot galvanizing; "dross" and oxides eliminated.

1,133,635. Art of Submarine Signaling; W. Hahnemann and H. Hecht, Kiel, Germany. App. filed May 22, 1913. Microphone subjected to pressure by vibration of tuning fork.

1,133,641. Plate for Electrical or Secondary Batteries or Accumulators; E. Hancock and D. David, Cardiff, England. App. filed Aug. 25, 1914. Uses paste of oxides of lead, sulphuric acid and substance rich in carbo-hydrates.

1,133,663. Distant-Control System for Electric Motors; G. A. Pierce, Philadelphia, Pa. App. filed Aug. 9, 1911. Especially for submarines.

1,133,671. Method of and Apparatus for Arresting Electric Currents; A. R. Sharples, Philadelphia, Pa. App. filed June 7, 1912. Porous electrodes feed liquid to spark-gap.

1,133,675. Reversing Mechanism for Electric Motors; H. Steinhart, Stuttgart, Germany. App. filed June 4, 1914. Conducting members for the brush-holders are interchangeable to reverse motor.

1,133,689. Electric Burglar-Alarm System; J. P. Williams, New York, N. Y. App. filed Nov. 22, 1910. Obviates employment of time mechanism.

1,133,726. Method of and Apparatus for Sending Signal Impulses; A. N. Hovland, Christiania, Norway. App. filed Feb. 12, 1912. For obtaining accurate co-operation of two or more machines.

1,133,750. Transformer; T. Shaw, Hackensack, N. J. App. filed Sept. 29, 1913. Balanced to minimize "cross talk" in phantom circuits.

1,133,783. Controller for Lighting Circuits of Dynamo-Battery Equipments; V. G. Apple, Dayton, Ohio. App. filed May 19, 1914. Operated by key which when removed leaves face of auto dashboard clear.

1,133,786. Multiple-Contact Relay; G. Babcock, Rochester, N. Y. App. filed Sept. 21, 1912. For automatic or semi-automatic telephones.

1,133,787. Relay Device; G. Babcock, Chicago, Ill. App. filed Oct. 6, 1913. Compact and accessible for adjustment and repair.

1,133,796. Telephone-Exchange-System Impulse Transmitter; J. Erickson, Chicago, Ill. App. filed June 14, 1909. Back-and-forth rotary dial.

1,133,806. Process of Electrically Uniting Metallic Members; L. S. Lachman, New York, N. Y. App. filed Oct. 19, 1910. Parts welded together with interposed member between.

1,133,819. Railway Switching and Indicating Circuits; W. H. Reichard, New York, N. Y. App. filed Aug. 17, 1910. For switching and indicating back.

1,133,833. Head Support for Telephone Receivers; C. Adams-Randall, Boston, Mass. App. filed Jan. 20, 1914. Readily adjustable to suit all conditions.

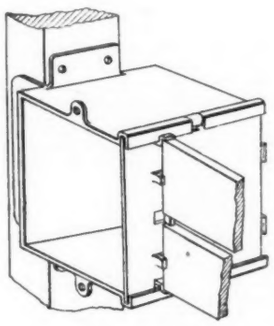
1,133,834. Dynamo-Electric Machine; D. Balachowsky and P. Caire, Neuilly-sur-Seine, France. App. filed June 16, 1909. Means controlled by shifting of neutral line due to armature reaction for varying strength of the field.

1,133,923. Telephony; S. G. Brown, London, Eng. App. filed July 6, 1914. Telephone relay system.

1,133,946. Switch Box; R. P. Farrell, Oxnard, Cal. App. filed Feb. 17, 1912. Attachable to studding and has means for attachment of laths thereto.

1,133,967. Apparatus for Electro-Osmotic Process; H. Ilig and B. Schwerin, Frankfort-on-the-Main, Germany. App. filed Feb. 26, 1914. Suspension washes against a large cathode surface.

1,133,971. Truck Connection for Locomotives and Cars; W. F. Kiesel, Jr., Altoona, Pa. App. filed Dec. 8, 1914. Special structure for excessive cab length.



1,133,946—Switch Box

1,133,976. Cable Rack; J. Kraus, Kimberly, Wis. App. filed Nov. 12, 1913. Built-up unit construction.

1,133,990. Ignition Dynamo; C. T. Mason, Sumter, S. C. App. filed July 28, 1913. Reduces end friction of rotating element.

1,134,007. Method of Uniting Sheets of Brass, Auminum and Other Metals or Alloys of High Conductivity for Heat; N. Prostler, Berlin, Germany. App. filed Nov. 11, 1912. Abutting edges are fused and melted together by electric current and pressure.

1,134,018. Paper-Perforating Machine; J. T. Schaaff, Washington, D. C. App. filed July 21, 1914. Keys close circuits through magnet-operated punches. (Forty-two claims.)

1,134,058. Ignition Apparatus for Explosion Engines; E. L. Parris, Jr., New York, N. Y. App. filed May 1, 1914. Vibrating electromagnet combined with magneto having primary and secondary windings on its armature.

1,134,059. Sound-Transmitting Apparatus; M. E. Pearson, Seattle, Wash. App. filed Jan. 20, 1913. Amplifier.

1,134,064. Fire-Alarm System; J. B. Ammons, Houston, Tex. App. filed Jan. 21, 1915. Employing minimum number of line and lead wires.

1,134,071. Wigwag Flagman; J. A. Bell, Los Angeles, Cal. App. filed Jan. 31, 1914. Vibrating signal for railway crossings.

1,134,081. Process for Producing Carbides of Silicon and By-Products; Chicago, Ill. App. filed July 17, 1912. Carborundum process.